A Network-Centric Operations Case Study:

US/UK Coalition Combat Operations during Operation Iraqi Freedom

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INTRODUCTION

The purpose of the Network-Centric Operations Case Study Series is to provide a coherent body of knowledge that both describes how networked organizations operate and identifies the critical factors for organizations to transform to enable network-centric operations.

Network-Centric Operations are a central element of the Department of Defense's ongoing transformation and an emerging American way of war. Broadly speaking, network-centric operations are characterized by the ability of a networked organization to develop and exploit an information advantage to improve organizational performance.

The concept of network-centric operations and the emerging network-enabled capabilities of U.S. and coalition forces were evident during Operations Iraqi Freedom. This case study, "US/UK Coalition Combat Operations during Operation Iraqi Freedom," describes how Coalition Forces were able to exploit the power of network-enabled capabilities to improve their operational effectiveness. Specifically, this study examines how U.S. and U.K. ground forces employed and exploited Force XXI Battle Command Brigade and Below (FBCB2)/Blue Force Tracker (BFT) in concert with existing C4 capabilities to conduct major combat operations.

While the study demonstrates that FBCB2/BFT made a significant contribution to combat effectiveness, it also highlights disparities that existed between coalition forces in their ability to exploit the technology. It also underscores that it is not enough to field a new technology; units also must have time to train and develop tactics, techniques, and procedures to realize the full benefits of network-enabled capabilities.

The Office of Force Transformation conducted this case study in collaboration with the United Kingdom's Ministry of Defense.

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This study was conducted for the Office of Force Transformation by Evidence Based Research, Inc and PA Consulting Group. The principal authors from PA Consulting Group were: David Mawby, Ian McDougall (both PA UK) and Greg Boehmer (PA US). The authors gratefully acknowledge the assistance of the UK Ministry of Defence and Evidence Based Research.

In particular, the authors give special thanks to the staff and subordinate units of the following formations for affording us their time for the face to face interviews: 1 (United Kingdom) Armoured Division, 3 Commando Brigade, 7 Armoured Brigade and 16 Air Assault Brigade, 3rd (United States) Infantry Division and 1st Brigade Combat Team. Additionally, thanks to the many individuals from the following units and organizations who provided additional information through more general interviews and meetings including: staff from the 1 Marine Expeditionary Force (1MEF), 15 Marine Expeditionary Unit (15MEU), HQ USMC C4/CS, CENTCOM (C4I Systems Integration, J3), the FBCB2 Program Office, and the US Army War College.

OFT and the authors would also like to provide special acknowledgements the efforts of the following individuals who provided support, including peer review, throughout the entire study:

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PREFACE

Over the past decade, the US Department of Defense (DoD) has embraced and begun implementing doctrine, concepts, and systems of Network Centric Warfare (NCW). NCW draws together a powerful set of warfighting concepts and associated military capabilities that enable warfighters to exploit information in order to bring assets to bear in a rapid and flexible manner. As noted in the 2001 NCW Report to Congress, *"Network Centric Warfare is no less than the embodiment of an Information Age transformation of DoD".* Further highlighting this, Dr. David Alberts, in his book Information Age Transformation: Getting to 21st Century Warfare, states that:

> *"There is a direct connection between an organization's agility and its ability to bring all of its information to bear in developing an understanding of a situation and all of its assets to bear in responding to a situation. For this reason, a business model based on these characteristics is ideal for an Information Age military. Network Centric Warfare is a military business model (a way to create a competitive advantage and value) that has these desirable characteristics. Thus, the transformation to an Information Age Business model is inseparable from progress toward network-centric operations."*[1]

Similarly, key US allies and coalition partners are placing an increased emphasis on NCW or Network Centric Operations (NCO)[2], or their equivalents like Network Enabled Capabilities (NEC) in the United Kingdom. Given this, coupled with Alberts' observation that transformation is also *"inherently joint and coalition"*, the DoD seeks to achieve sufficient interoperability to ensure successful joint, multi-national, and interagency operations at all levels of warfighting, and across the spectrum of potential engagement scenarios.[3] Thus interoperability is not an end in itself, but a means to an end.

Both the concept of interoperability and the specific tenets of NCW focus on maximizing combat capabilities. Combat operations of the future will most likely be conducted in an alliance or coalition environment and will inevitably be joint as well as combined - underscoring the importance of interoperability with our allies and coalition partners. More than ever before, technology provides us with the tools necessary to achieve the desired levels of NCO capabilities, greater sharing of improved data in near real time and better situational awareness.

In light of Operation IRAQI FREEDOM, we have recent and rich examples of allied and coalition combat operations that leveraged many of the advanced technologies designed to support improved interoperability and the tenets of NCW. This report represents a case study using the NCO Conceptual Framework (NCO CF) that enables us to capitalize on some of the data regarding coalition operations specifically relating to the joint operations of US and UK

1 Network Centric Warfare Department of Defense Report to Congress. "Executive Summary." July 2001. p i.

2 As noted in Network Centric Operations Conceptual Framework, Version 1.0 , EBR, 11/2003, the terms Network Centric Warfare (NCW) and Network Centric Operations (NCO) are used interchangeably in this Final Report. As noted in the same reference, " the latter term (NCO) is preferred because it implies correctly that the theory of Network Centric Warfare applies to a much broader domain of phenomena and is not limited to warfare".

3 Alberts, David S. *Information Age Transformation: Getting to a 21st Century Military*. June 2002.

forces in southern Iraq. Based on analysis using the NCO CF, its attributes and metrics, we are better able to determine the degree of network centricity that was achieved, measure the impact of network centricity on force performance/effectiveness, and identify a set of objectives and recommendations that will provide the basis for improvements and, ultimately, the continued successful transformation of our military to meet the emerging threats and challenges of the 21st century.

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1. OBJECTIVES FOR THIS STUDY

1.1 INTRODUCTION

In June of 2003, PA was retained, via a contract with Evidence Based Research (EBR) under the Office of the Secretary of Defense Office of Force Transformation (OSD OFT) and the Office of the Assistant Secretary of Defense for Networks and Information Integration (OASD NII), to conduct an assessment of US/UK coalition combat operations during Operation IRAQI FREEDOM (OIF) using the Network Centric Operations Conceptual Framework as the basis of the analysis. The scope of the work was as follows:

- Develop a case study/studies that examines major combat operations with Allied/Coalition Partners.
- Apply the NCO Conceptual Framework to major combat operations with Allied/Coalition Partners.
- Identify specific objectives whose achievement will help enable more mature US/UK network-centric operations.
- Consider insights gained from UK application of Blue Force Tracking during Operation IRAQI FREEDOM
- Assess the NCO CF's ability to explain key underlying relationships between input variables and output measures
- Improve and codify the underlying theory of network centric operations through critical feedback on the utility of the conceptual framework for analysis and assessment of network centric operations

As the reader will note, while this case study has gone through significant evolution over time based on the research, analysis and ongoing dialogue in the NCO CF workshops, the general scope of using the NCO CF as the basis for assessment of US/UK coalition combat operations during OIF has remained the general focus and driver for the case study.

1.2 NETWORK CENTRIC OPERATIONS CONCEPTUAL FRAMEWORK

Network Centric Warfare theory serves as the basis for, and drives, this entire case study. "The OFT has determined that NCW is the core concept that guides the transformation of the U.S. military. NCW is the embodiment of Information Age warfare. It is a new theory of war based on Information Age principles and phenomena, and can be summarized by the *tenets.* These state that a robustly networked force improves information sharing and collaboration, which enhances the quality of information and shared situational awareness. This enables further collaboration and self-synchronization and improves sustainability and speed of command, which ultimately result in dramatically increased mission effectiveness".[4] The Network Centric Operations Conceptual Framework as shown in Figure 1.1 below provides

4 Evidence Based Research Incorporated, "Network Centric Operation Conceptual Framework", Version 1.0, dated November 2003

us with a "means to evaluate NCO hypotheses" and "clarifies and illuminates important aspects of NCO theory that were only implicit in the original tenets".[5]

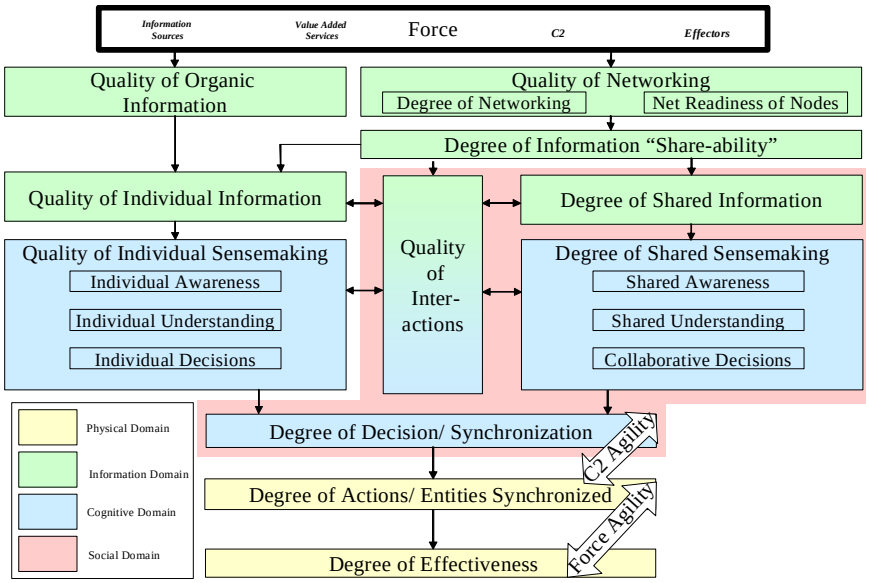


Figure 1.2-1 Network Centric Operations Conceptual Framework

1.3 APPLICATION OF THE NCO CF

It is not the intention of this case study to provide a tutorial on the NCO Conceptual Framework (NCO CF), however a very brief discussion of it relative to the focus of study will assist the reader in better understanding the basis for the objectives of this study and how we apply the framework. The following figure depicts those top-level concepts (bolded and outlined in red) and, ultimately of the NCO CF that were "exercised" relative to our research. As will be noted later in this document, specific questions (both open and quantitative) were developed relative to the top-level concepts of Quality of Individual and Shared Sensemaking and Quality of Interactions. The case study also addressed general, and higher level questions, around Quality of Networking and Degree of Effectiveness. Each of the concepts within the NCO CF is further described by a set of attributes and metrics at a second level - these attributes allow us to measure concept characteristics in terms of quantity and quality.

5 ibid

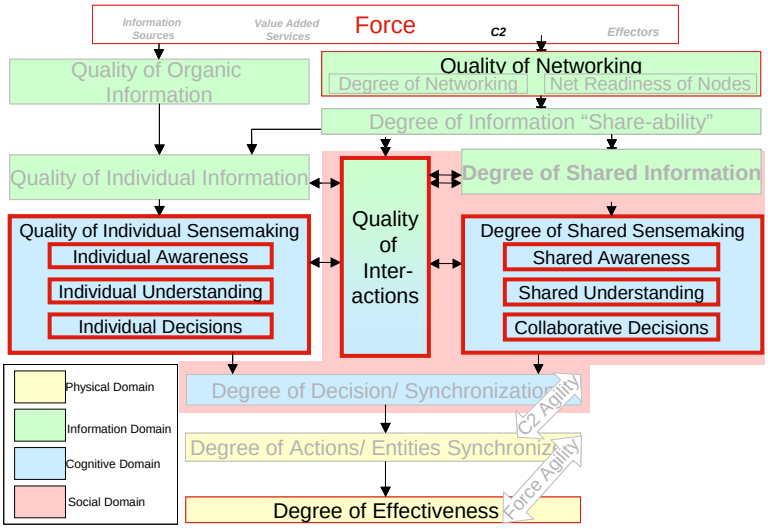


Figure 1.3-1 Network Centric Operations Conceptual Framework

Each of these attributes in turn is defined by a metric or set of metrics. For example, the figure below illustrates the relationship of one of the concepts that is the focus of our case study, Individual Sensemaking, to one set of its corresponding attributes (currency, precision, consistency, uncertainty, and relevance).

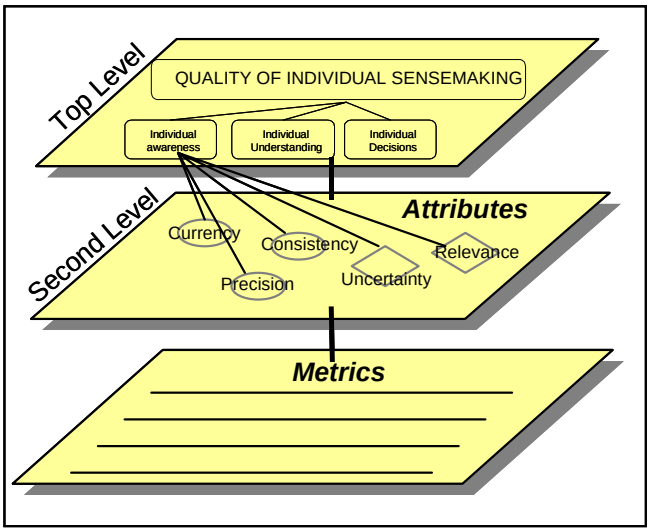


Figure 1.3-2: NCO CF Top level concepts & second level attributes and metrics

As such, the NCO CF allows us to construct and test hypotheses regarding the relationship of the various top-level concepts, associated attributes and metrics.

1.4 OBJECTIVES OF THE PA CASE STUDY

With this basic understanding our application of the NCO CF, the purpose of the case study is to conduct research that results in testing (either supporting or not) the following hypothesis:

> *During Operation TELIC (UK operation name) and Operation IRAQI FREEDOM (OIF), the direct accessibility to Network Centric Operations (NCO) capabilities by UK and US combat units provided 1) improved individual sense-making; 2) enhanced quality of interactions; 3) improved shared sense-making; and, 4) ultimately, increased mission effectiveness relative to previous operations and training without these NCO capabilities.*

As stated, the baseline of our study becomes combat units as they were equipped and operated prior to line of departure or pre-OIF when they were not equipped with FBCB2/BFT. The treatment, on the other hand, becomes those same units after they were equipped with Force XXI Battle Command Brigade and Below (FBCB2) Blue Force Tracker (BFT) during OIF. This will be discussed in greater detail in our "Approach" section.

In looking at the application of FBCB2/BFT, we will evaluate, at a higher level, the top-level concept of "Quality of Networking". Our research also generally will evaluate increases in the ultimate "output" of the process: the Degree of Effectiveness" (mission effectiveness). This is realized through agility (of C2), tempo and synchronization. At a more general level, we attempt to assess if the treatment ultimately assists combat units in innovation either by 1) doing things better or, 2) doing better things. This will be addressed later in this document.

2. SCOPE AND ASSUMPTIONS

2.1 SCOPE

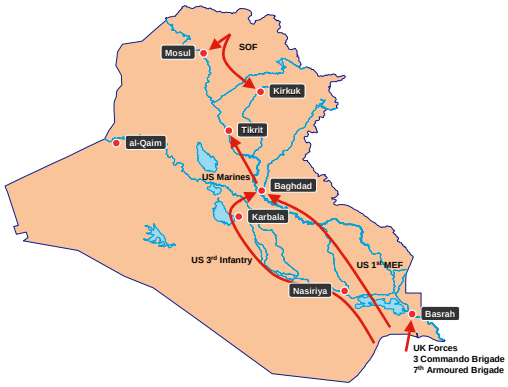
In order to contain the scope of this study, major decisions had to be taken early in the project as to

- which combat operations represented the richest example of coalition operations,
- which units within those operations would be the focus of the study, and
- what the primary data collection approach would be.

Based on our chosen data collection approach of face-to-face interviews, we also had to determine which individuals from which units, and how many, involved in which operations would be interviewed. We also needed to decide at what level within the hierarchy of command, tactical versus operational/strategic, we would conduct the interviews.

2.1.1 Scope of OIF combat operations and combat units to be studied

In the process of selecting our case study, we assessed multiple combat operations conducted by coalition forces in Operation IRAQI FREEDOM to determine which would represent the most robust candidate for research. As discussed in Section 3, coalition operations in Southern Iraq represented the largest and richest example of coalition combat operations. Even with the focus on coalition operations in Southern Iraq, the possible scope of this study could have entailed meetings/interviews with multiple levels of the Joint Coalition Environment. These included Central Command (CENTCOM), the United Kingdom National Contingent Command (UK NCC), the Land Component Command (LCC), the Air Component Command (ACC), the Maritime Component Command (MCC), 1st Marine Expeditionary Force (1 MEF), V Corps, 3rd Infantry Division (3ID) and 1st (United Kingdom) Armoured Division (1 (UK) Armd Div). Ultimately, it was decided to focus our initial efforts on the UK land contingent, 1 (UK) Armd Div. It should be noted that the UK formation was subordinate to 1MEF (US) and that within 1MEF, 15 MEU, for a period of time, was deployed subordinate to 3 Commando Brigade (3 Cdo Bde). Based on findings relating to the deployment and use of FBCB2/BFT within the UK combat units, the scope was later expanded to include the 3ID (1st Brigade Combat Team) in order to provide additional contrast/comparison and explore difference and similarities in findings.



As such, the following diagram, Figure 2.1.1-1, represents those units potentially included in the scope of our research and highlights those units that ended up as the focal points of our case study interviews.

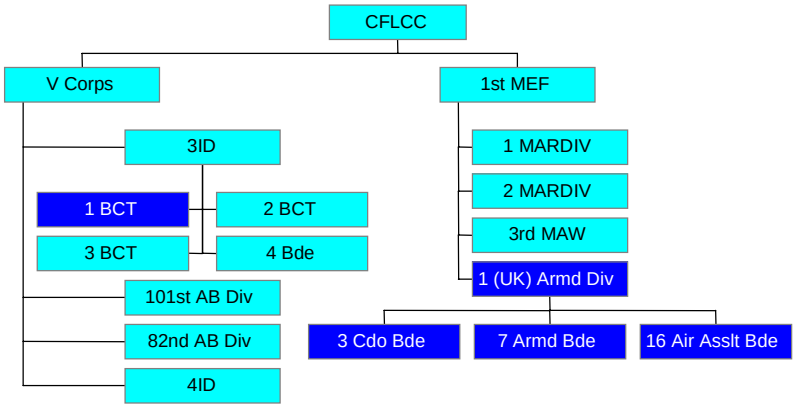


Figure 2.1.1-1: Potential and actual units interviewed (actual units shown in dark blue)

2.1.2 Approach to data gathering as relates to scope

The approach chosen to collect data determined to a large degree the number of actual individuals within combat units included within the scope of our case study. An early decision was made to conduct our research using face-to-face interviews and, where possible, use two interviewers for each interview. It was also agreed to by the study team (during the first workshop session) that we needed to find a balance between capturing the stories/vignettes of individuals in the combat units, as well as quantitative evidence, that illustrated or substantiated any transformation to network centric operations (see "Assumptions" below). Given this and time associated with the data collection and analysis, the number of units contacted and individuals interviewed had to be limited.

2.1.3 Tactical versus operational

In conjunction with the above, we decided to focus first on the lower level, tactical combat units in order to capture their stories relating to actual combat operations, application of FBCB2/BFT and its contribution to overall combat effectiveness. Higher-level interviews would be conducted if adequate time and resources remained, or, at a minimum, as a means of informing our detailed data gathering.

2.1.4 UK MOD funding

In January of 2004, the UK MOD, through CBM J6, provided additional funding to the PA team in order to support additional interviews of UK units and to support PA participation in interviews, with the Army War College, of individuals from 3ID 1BCT at Ft. Stewart, GA and from 3ID, V-Corps and Combined Forces Land Component Command (CFLCC) who were at the Army War College, Carlisle Barracks, PA.

2.2 ASSUMPTIONS

The following section documents major assumptions that we made during our case study.

- Initial meetings and discussions during the first two workshops led to the conclusion that the PA case study team needed to find a balance between evidence based research and quantitative analysis versus a more subjective and qualitative analysis that let the

individual combat units tell, and PA capture, their "story" and significant vignettes that supported (or did not support) the hypothesis and evidence of transformation. As discussed in our Approach sections, PA's interview process placed priority on the latter while trying to capture a component of the former through quantitative questions.

- The total number of face-to-face interviews would be limited due to the location of units, coordination with units, travel, time to conduct interviews, time to translate results, etc. This would imply that the results, especially the statistical results of quantitative questions and analysis, may not be rigorous enough to support statistically significant hypothesis testing. This was countered by the fact that the interviewees identified needed to be and were considered to be subject matter experts and key decision makers in the units with first hand experience using, and knowledge of the deployment of, FBCB2/BFT. This means that a smaller number of interviews will provide greater validity.
- Budget considerations – i.e. "not to exceed" amount – determined decisions relating to scope – this included labor and travel.
- Limiting the number of interviews would be balanced by focusing on subject matter experts from the units within the scope of the study.
- Number of domains/concepts from NCO CF would be restricted during the initial case study.
- The NCO CF would be used as the basis for analysis.
- A major objective of the case study would be to capture "vignettes/stories" and focus would be on face-to-face interviews versus mass distribution of questionnaires or web based data collection. Face to face interviews involving two individuals would be the normal mode of gathering data (this is discussed under Approach).
- The NATO Code of Best Practices for C2 Assessment (Revised 2002) was used as a reference, where applicable, to assist in structuring our approach to this case study.

2.3 CONSTRAINTS

The following section identifies what PA considered (considers) to be key constraints relating to this case study.

- Unit availability was a factor that drove whether or not we were able to interview certain individuals. Dispersal of individuals from various combats units after OIF also required careful selection and planning of any interviews to control travel costs. During this case study, we had to coordinate interviews with elements of the 1st (United Kingdom) Armoured Division, 7 Armoured Brigade, 3 Commando Brigade, 16 Air Assault Brigade, US 3 Infantry Division (3ID) 1 Brigade Combat Team (1 BCT). This entailed conducting interviews in the UK, Germany, Norway, Ft. Stewart, Georgia, and Carlisle Barracks, Pennsylvania. While most desired interviews were successfully conducted at these locations, there was one UK unit (1st Battalion The Black Watch) with which we were unable to schedule an appropriate time and ended up not conducting interviews.
- The "not to exceed" nature of funding did not allow for expanding scope of study as additional areas of interest or opportunities for study were identified during research and analysis.

- This case study has remained **unclassified**. This has restricted access to certain data that remained classified during the period covering the case study.
- Blue on blue incidents (fratricide) were removed from the scope of this case study as a result of discussions and agreements reached during NCO CF Workshop #1. This was owing to the lack of reliability of public data, lack of access to classified data on the subject, and sensitivity owing to some ongoing incident investigations (both US and UK).

3. OPERATIONAL CONTEXT FOR THE STUDY

3.1 POLITICAL/MILITARY OVERVIEW

Following military operations in 1991 to expel Iraqi forces from Kuwait, the UN imposed strict sanctions on Iraq to remove the threat that Saddam Hussein's regime posed to neighboring Middle Eastern countries. The sanctions included the detection, destruction, removal or rendering useless of weapons of mass effect (WME). This action was to be undertaken by the UN Special Commission (UNSCOM) and the International Atomic Energy Authority (IAEA). The teams were obstructed in their tasks by the Iraqi Regime and were withdrawn to be replaced by a UN Monitoring and Verification and Inspection Commission (UNMOVIC) in 1999. Iraq, however, continued with a strategy of non-compliance.

In November 2002, the UN Security Council passed Resolution (UNSCR) 1441 declaring Iraq in material breach of previous resolutions. The Resolution articulated new procedures for the conduct of inspections and the threat of serious consequences for the lack of compliance. UNMOVIC inspectors re-visited Iraq but reported evidence of systematic patterns of concealment and deceit by the Regime.

The US led a coalition of nations that was prepared to use force to secure compliance by Iraq to adhere to previous UN sanctions. The aims for the use of force were:[6]

- To overcome the resistance of the Iraqi armed forces
- Deny the Iraqi regime the use of weapons of mass effect
- Remove the Iraqi regime due to its refusal to comply with the demands of the UN Security Council
- Identify and secure the sites where WME and their means of delivery were located
- Secure essential economic infrastructure
- Deter wider conflict in Iraq and the environs

In achieving these aims, the Coalition was intent on minimizing the degree of collateral damage, notably minimizing civilian casualties, limiting damage to civilian infrastructure and addressing any subsequent humanitarian events.

The US Government aspired for regime change to bring about a change in the environment in which the Iraqi people survived; the UK Government sought the eradication of any weapons of mass effect possessed by the Regime. On 24 February 2003 the US, UK and Spain tabled a draft resolution describing that Iraq had failed to comply with UNSCR 1441. As a consequence, threatened military operations were realized and operations against Saddam Hussein and his regime started on 20 March.

6 UK MOD "Operations in Iraq, First Reflections", July 2003.

The Coalition consisted of 30 nations, several of which committed to contribute military effort; the US, UK, Australia and Poland contributed military personnel. Overall force numbers totaled in excess of 350,000. After a more than a decade of arms embargo, the Coalition faced an Iraqi force that was significantly degraded from 1991. Manpower was estimated at roughly 50% of its 1991 level[7]. While estimates of functional equipment developed by the Center for Strategic and International Studies in 2002 indicate a similar erosion of capabilities with available equipment totaling between 2,000 and 2,600 tanks, 3,700 armored vehicles, and 300 combat aircraft,[8] the sophistication and availability of chemical and biological weapons that may have been controlled by the Iraqi regime remained largely unclear.

Objectives

CENTCOM devised a plan for overwhelming affect, capitalizing on superior combat power. The aim was to target key objectives with precision weapons to dislocate Iraqi command and control that would facilitate Coalition freedom of maneuver. The US Secretary of Defense, Donald Rumsfeld, articulated Coalition objectives as follows[9]:

- First, end the regime of Saddam Hussein
- Second, to identify, isolate and eliminate Iraq's weapons of mass destruction
- Third, to search for, to capture and to drive out terrorists from that country
- Fourth, to collect such intelligence as we can related to terrorist networks
- Fifth, to collect such intelligence as we can related to the global network of illicit weapons of mass destruction
- Sixth, to end sanctions and to immediately deliver humanitarian support to the displaced and to many needy Iraqi citizens
- Seventh, to secure Iraq's oil fields and resources, which belong to the Iraqi people.
- And last, to help the Iraqi people create conditions for a transition to a representative self-government.

3.2 ORGANIZATION

US Central Command (CENTCOM) commanded Maritime, Air, Land, Special Forces and Logistic Components. UK contingents were embedded in all US components less the Joint Force Logistic Component (JFLogC). CFLCC commanded V Corps and 1st MEF. 1 (UK) Armd Div was subordinate to 1st MEF. The organizational structure of the Land Component, highlighting those formations and units studied during this research project, is at Figure 3.2-1.

[7] CRS Report RL31701, *Iraq: US Military Operations*, Updated April 14, 2003.
[8] Cordesman, Anthony. *Iraq's Military Capabilities in 2002*. Center for Strategic and International Studies. September 2002.
[9] Cordesman, Anthony. *Iraq's Military Capabilities in 2002*. Center for Strategic and International Studies. September 2002.

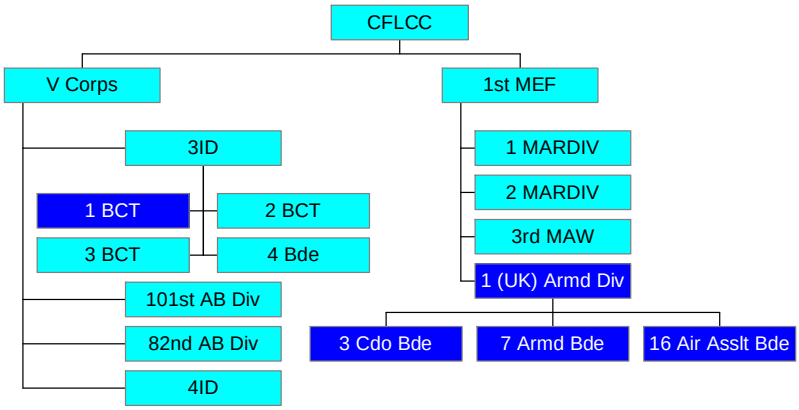


Figure 3.2-1, Operation IRAQI FREEDOM Land Component

3.3 SCHEME OF MANEUVER

UK-led coalition forces concentrated on securing the Al Faw peninsula, the port of Umm Qasr and Basrah, while US-led coalition forces executed a two-pronged advance towards Baghdad; the 3rd Infantry Division (3ID) to the southwest following the axis of the River Euphrates and the 1st Marine Expeditionary Force (1MEF) from the southeast following the axis of the River Tigris. The objectives of this research were to focus, specifically, upon the experiences of 1st (United Kingdom) Armoured Division (1 (UK) Armd Div) and 1st Brigade Combat Team (1 BCT), a formation of 3ID. Specific objectives of the formations were as follows:

- 1 (UK) Armd Div
  - 3 Cdo Bde seized the Al Faw Peninsula in a joint operation with US Special Forces. The Al Faw manifold and metering station was essential in the control of the passage of crude oil from oil production facilities inland to the offshore export terminals in the Northern Arabian Gulf (Mina al Bakr and Khawr al Amaya). Thereafter, the Brigade seized and secured the port of Umm Qasr that was required to facilitate the entry of humanitarian aid, by sea, into Iraq following hostilities.
  - 7 Armd Bde seized critical oil infrastructure in southeast Iraq, particularly the Az Zubayr pumping station. They then seized and secured Basrah International Airport prior to securing Basrah, the second city of Iraq, through a complex operation coordinated with sister brigades in 1 (UK) Armd Div.
  - 16 Air Assault Bde secured critical oil infrastructure in the Rumalyah oilfields, including gas and oil separation plants and pumping stations. They provided a security screen on the northern boundary of the Divisional area of responsibility.
- 1 BCT cleared and secured lanes along the Kuwait – Iraq border to facilitate Coalition movement into Iraq. The Brigade seized Jalibah Airfield for use as an aviation forward operating base. The Brigade moved quickly north-west seizing a number of critical crossing points on the River Euphrates at As Samawah, An Najaf and in the vicinities of Al Hilliah and Karbala. Brigade units faced concerted resistance throughout. Their final objective was to seize Baghdad International Airport prior to conducting stabilization operations in Baghdad.

The broad scheme of maneuver for the Coalition is shown in Figure 3.3-1.

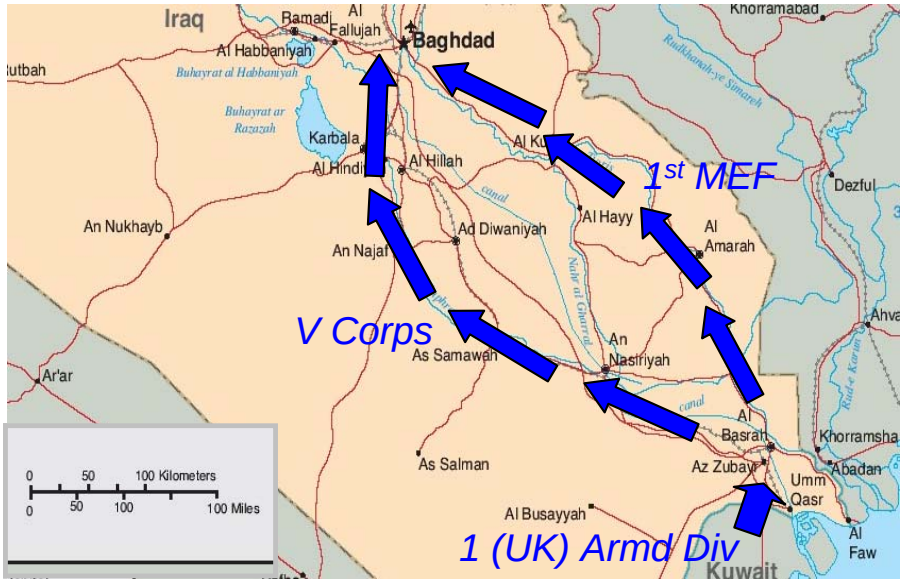


Figure 3.3-1, Coalition Scheme of Maneuver

3.4 RATIONALE FOR THE DEPLOYMENT OF FBCB2/BFT

Force XXI Battle Command Brigade & Below/Blue Force Tracker (FBCB2/BFT) was in the process of being introduced into the US military prior to Operation IRAQI FREEDOM/TELIC.[10] In the lead-up to the Operation, Lieutenant General David McKiernan, Commander CFLCC, declared that he "*wanted to know where Land Component units were*".[11] As a result, production of FBCB2/BFT systems was increased in order that a blue force tracking capability could be deployed in readiness for the operation.

In Great Britain, at the time UK forces were preparing a range of options to support US forces, combat identification (combat ID) was a topical issue and the Secretary of State for Defence, the Right Honorable Geoff Hoon, had stated that UK forces would be provided some combat ID capability. It was recognized that there were systems for combat ID in the maritime and air components but there was little capability in the land component. Consequently, the UK MOD wanted to procure a system that was compatible with the US. There were a number of options to meet the UK MOD requirement:

- Purchase a new system;
- Lease a system that was compatible;
- Embed US personnel with FBCB2/BFT within UK units.

The last option was preferred because it caused no training burden to the UK, however, it was recognized that the US government was unlikely to sanction this aspiration.

10 TELIC was the UK codename for military operations in the Middle East.

11 Drawn from an interview with Wg Comd Dixon RAF, MOD UK

Consequently, it was decided that the UK would lease a number of FBCB2/BFT systems from the US. These systems would be fitted following the US model of equipping main and alternate HQs in order to track a unit's center of mass. In principle, this was consistent with the deployment of the system in 3ID[12] although, unlike the deployment to company level within the 3ID, with the exception of the UK 7th Armoured Brigade, FBCB2/BFT units were not deployed below the battlegroup level (this is discussed later in this report). FBCB2/BFT was fitted to UK vehicles in Kuwait during February and March 2003 by US contractors. The UK received 47 systems that were deployed as shown in Figure 3.4-1.

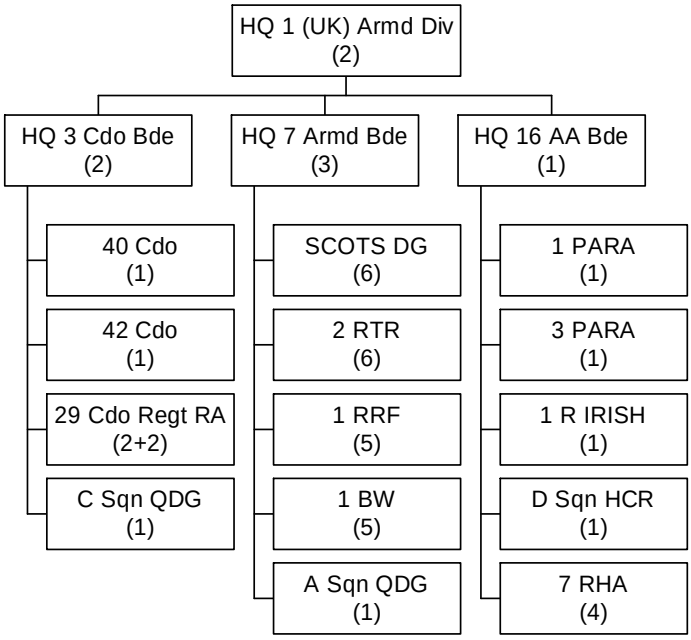


Figure 3.4-1, FBCB2/BFT Deployment in 1 (UK) Armd Div

FBCB2/BFT was fitted to a range of vehicles, including Challenger 2 Main Battle Tanks, Warrior Infantry Fighting Vehicles, Combat Vehicle Reconnaissance (Tracked) and Land Rovers. Each fitting was discrete; the equipment often being located where there was available space. This provided a rudimentary capability for enhanced situational awareness in each of the vehicles if, somewhat, ergonomically inefficient.

3.5 A FUNCTIONAL DESCRIPTION OF FBCB2

The Force XXI Battle Command Brigade & Below system (FBCB2) is the principal digital command and control (C2) system for the US Army at brigade level and below. The system is an automated, network-enabled command and control system, which provides brigade-and-below elements with a seamless battle command capability. The computer, along with associated communication and GPS equipment, allows each platform user in the network to send and receive information across the depth and breadth of the battlefield. The system facilitates the flow of battle command information and supports lower echelon battle command tactical mission requirements. Additionally, it inter-operates with Army and Joint

12 Through an interview with LTC Bayer, G3 3ID.

C2 and other sensor systems on the battlefield, resulting in vertical and horizontal information integration. This shared common battlefield picture displays near real-time information which contributes to Situational Awareness (SA – blue, red and geo-reference), provides graphics and overlays, and allows the exchange of C2 messages (predefined and free text).

It is installed in tactical vehicles, weapons platforms, and aviation platforms. Each computer is tailored to a specific platform configuration to meet the needs of each role or mission. The system consists of commercial off the shelf (COTS) computer hardware (CPU and screen), system operating software, FBCB2 software, GPS device, installation-kit hardware, and communications network devices.

The whole system is interconnected through a terrestrial communications infrastructure called the Tactical Internet, which is based upon commercial Internet protocols and made up of existing Enhanced Position Location Reporting System (EPLRS) and Single Channel Ground & Airborne Radio System (SINCGARS) radios, and an Inter-network Controller (INC – a router). Alternatively systems can be connected using celestial satellite communications via an L-Band transceiver and operations center, and this is more commonly referred to as FBCB2 Blue Force Tracking. Both terrestrial and celestial-based systems can exchange information with each other.

Multiple versions of FBCB2/BFT hardware and software have evolved over the past several years. After equipping the 4th Infantry Division (4ID) with FBCB2 (EPLRS based), and giving a commercial version of the system to soldiers operating in the Balkans, a "Gulf Digitization Initiative" was launched to install a limited number of systems with US forces in the region. 216 systems utilizing an L-band satellite hub and computer server were initially installed, including movie theater-sized screens with hardware and software to operate and manage FBCB2/BFT at Camp Doha, Kuwait. With the impending operation (OIF), the number of L-band-enabled FBCB2/BFT units was significantly increased to approximately 900 and deployed with several units (primarily ground but some air) involved in OIF, including the 101st Airborne Division, 3rd Infantry Division (3ID), 1st (UK) Armored Division, V Corps, 1st Marine Expeditionary Force (1MEF) and the 1st (UK) Armoured Division. Ironically, 4ID, was the most heavily digitized force utilizing FBCB2 (initially EPLRS but later augmented with L-band BFT units), was not deployed to Iraq until much later.

Figure 3.5-1 shows the architecture of the FBCB2/BFT system. A platform position is transmitted to a satellite constellation, aggregated with other systems' positions and transmitted back to all platforms. There is also a feed into the Global Command and Control System (GCCS) that updates a common operational picture (COP) at formation level.

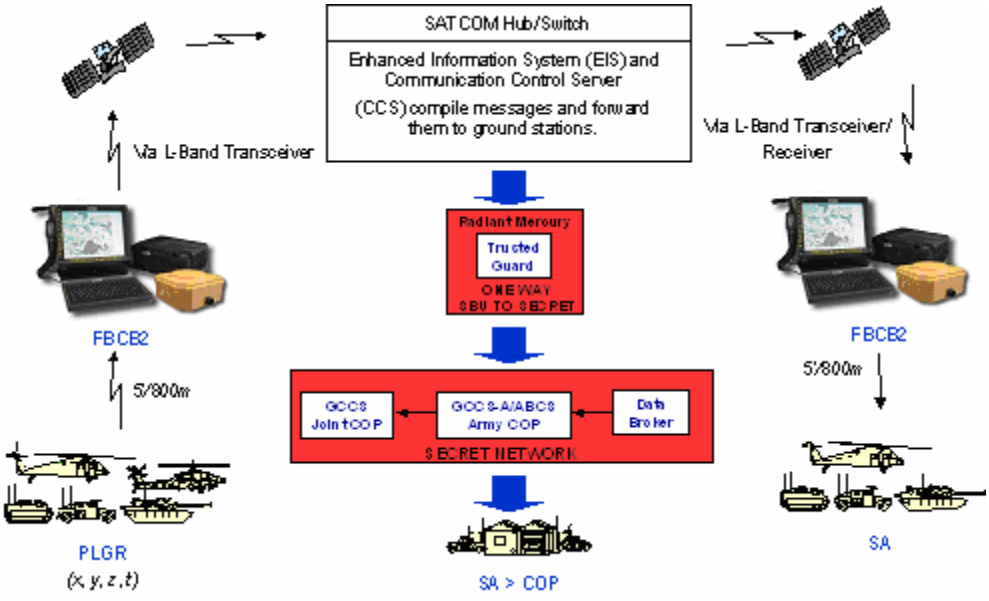


Figure 3.5-1 : FBCB2/BFT Communications Links

The system was deployed across the Coalition force as shown in Table 3.5-1 below.

	Ground	Air
101st AB Div	80	84
3d ID	150	15
1st AD	298	15
V Corps Troops	29	8
4 ID (3rd Bde)	41	0
3d ACR	47	10
2d LCR	49	0
Other (82d AA, CLFCC, etc)	46	0
USMC (1MEF)	109 (177)*	0
1 (UK) Armd Div	47	0
	895	132

Table 3.5-1: FBCB2/BFT Fielding

Figure 3.5-2 shows a typical installation and 3.5-3 a screenshot from FBCB2/BFT highlighting the locations of friendly forces.

Figure 3.5-2: Typical FBCB2/BFT Installation

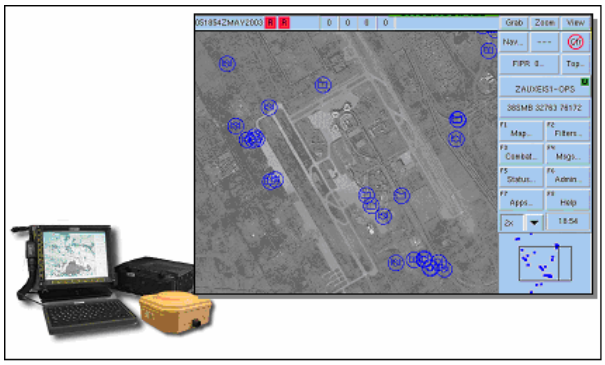


Figure 3.5-3: FBCB2/BFT Screen Shot

3.5.1 FBCB2/BFT – The system and its capabilities

FBCB2/BFT was a system designed to provide situational awareness. It comprises a personal lightweight GPS receiver (PLGR) and a data terminal that link to a satellite hub via L-band to create and maintain a method of tracking and communicating with other FBCB2/BFT systems. The system automatically updates its position every 5 minutes or if the platform has moved 800m. The system provides the following major capabilities:

- Positional information and navigation support
- Tactical messaging
- Graphical overlay creation and transmission
- The production and dissemination of reports and returns
- Limited terrain analysis

3.6 WHAT THE CASE STUDY ADDRESSES

3.6.1 Overview

The case study addresses the degree of improved situational awareness provided to UK and US forces through the deployment of FBCB2/BFT as well as some other communications capabilities (e.g. SATCOM). Situational awareness is assessed using the Network Centric Operations Conceptual Framework Model as a vehicle for the assessment, concentrating particularly on the quality of individual sense-making, the quality of interactions and the degree of shared sense-making and their individual and collective impact upon mission effectiveness. Data to support the analysis has been derived through personal interviews with military personnel operating FBCB2/BFT.

3.6.2 Situational awareness (SA)

There are numerous definitions of the term "situational awareness". In the U.K., situational awareness is a term used by the military to describe the fusion of information on the following to gain a perception of the operational or tactical context:

- Command intent
- Friendly forces
- Enemy forces
- The environment

This is consistent with U.S. definitions as well. These factors are all considered in time and space. The purpose of studying these elements of situational awareness is that they correlate well with the physical elements of the joint operational picture (JOP)[13] that includes other elements of situational awareness such as NBC, fires, logistics and meteorology. Command intent is included to set the context for the need for situational awareness. The layers of the JOP are highlighted in Figure 3.6.2-1.

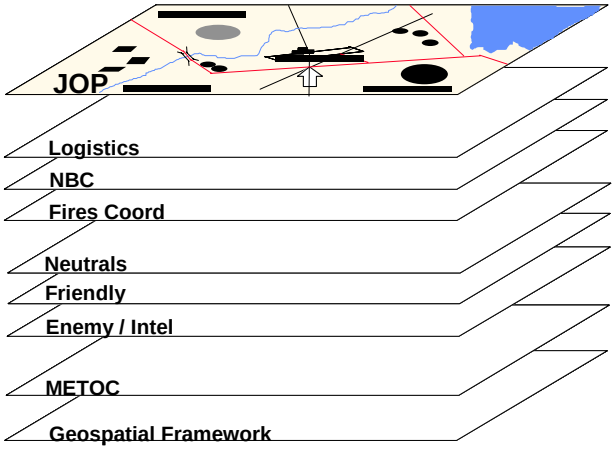


Figure 3.6.2-1, The UK Joint Operational Picture (JOP)

13 A UK concept linked to that of the US "common operational picture".

4. DESCRIPTION OF APPROACH

4.1 INITIAL RESEARCH DESIGN

During the initial phases of the case study, much was gleaned from reviewing a significant number of After Action Reports (AARs) – see Appendix B. This included information about the roles of relevant units, the nature of operations in OIF and some experiences regarding the use of FBCB2/BFT.

At the same time, initial contact was made with a number of individuals and organizations that had been involved in the decision-making about deployment, the fielding itself and operation of FBCB2/BFT during OIF. These were classified as "informing interviews" which informed the research design but, since they were not formally structured and recorded, were not utilized directly within the results of the research. They included:

- Several meetings with the FBCB2 project management office to more fully understand the nature of the system that had been fielded and its distribution amongst the different units;
- Meetings with elements of both UK and US forces to establish a high level view of the perceptions regarding utility of FBCB2/BFT in OIF and understand which units would be most likely to provide useful data and insights;
- Discussions with the research communities that had already contacted a number of the units concerned in preparation of AARs and other analyses.

As a result of these initial data gathering activities, a much clearer understanding was obtained that permitted the design of a robust research plan. Specifically, this enabled the development of a clear baseline against which the treatment could be compared, a definition of which variables within the NCO CF to consider and a first draft of the interview plan, as described below.

4.2 SUBSEQUENT RESEARCH DESIGN

4.2.1 Baseline

Since there were no brigades amongst the UK forces that were not equipped with any FBCB2/BFT it was not possible to compare equipped (i.e. treatment) brigades against non-equipped (i.e. baseline) brigades within the same operation. In any case, the nature of the three UK brigades was significantly different (Armoured, Air Assault and Commando) and they conducted different types of mission during OIF – so they would not have provided good comparators against each other. Therefore, it was decided to use the units own operations without FBCB2/BFT prior to OIF as the baseline. Most of the units concerned had recent relevant experience of large-scale exercises that covered similar types of operations to those conducted in OIF – but without the use of FBCB2/BFT. Examples of suitable exercises that could be referred to as baselines included an exercise in Poland, British Army Training Unit Suffield (BATUS) and Exercise SAIF SEREEA.

4.2.2 Variables

The areas of the NCO CF that the case study was going to concentrate upon were highlighted in Section 1.3. These can be isolated from the NCO CF and laid out as a causal chain as shown in Figure 4.2.2-1 below.

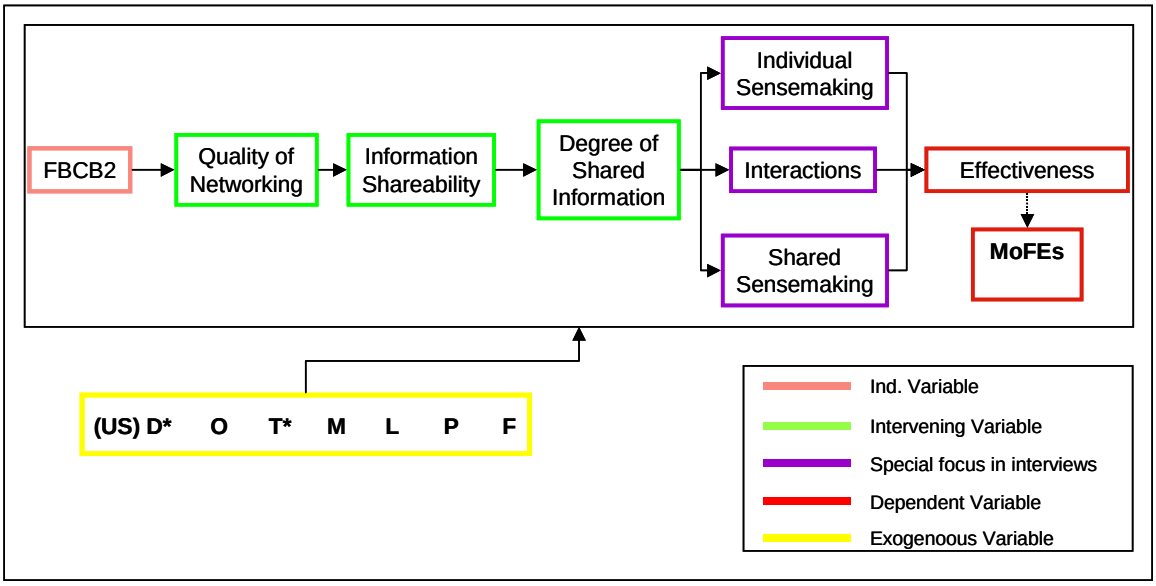


Figure 4.2.2-1 Variables

The dependent variable that we are interested in is effectiveness, as quantified by measures of force effectiveness (MoFEs) such as tempo, agility and synchronization. The case study hypothesis relates this back to the use of FBCB2/BFT as the independent variable, which in this case primarily altered the quality of networking available to forces in OIF. The main intervening variables that were going to be explored through interviews were: individual sensemaking, quality of interactions and shared sensemaking. The remaining intervening variables (information shareability and degree of shared information) could be considered at a high-level by looking at the FBCB2/BFT functionality, information flows and architectures available before and after treatment.

It was clear that the impact that FBCB2/BFT may have upon MoFEs could also be dependent upon a number of exogenous variables. The case study attempted to determine the effectiveness of the fielding program for FBCB2/BFT in delivering the potential improvements. This was achieved by asking interview questions regarding the deployment approach, training, development of tactics, techniques and procedures (TTPs) and whether the system's full potential had been achieved. These questions focused on all of the US lines of development – DOTMLPF (Doctrine, Organization, Training, Materiel, Leadership Development, Personnel and Facilities – the asterisks (*) indicate areas of primary interest within DOTMLPF although all were considered). Though not directly linked to the UK lines of development there is correlation between the lines of development between the nations, therefore, for simplicity the US DOTMLPF model has been utilized.

4.2.3 Interview plan

Since each unit interviewed would be providing its own baseline through reference to previous similar exercises or operations, there would be no point interviewing anybody other than FBCB2/BFT-equipped units.

Within the UK contingent the density of deployment of FBCB2/BFT units was relatively low (47 units to the entire 34,000 UK troops in OIF) so it was necessary to identify exactly whose vehicles the FBCB2/BFT units had been fitted in. The strategy was to interview the commanders in whose vehicles the FBCB2/BFT units had been fitted – and these ranged from Division to Company level in the UK forces.

With a far larger population of FBCB2/BFT equipped American units, the strategy for selecting interviews was based upon achieving a reasonable coverage of echelons while minimizing the number of sites that had to be visited.

In reality the number of interviews was severely constrained by the research funds that were available. With extra support provided by the UK Ministry of Defence it was eventually possible to conduct around 50 interviews – of which 29 were formally structured and contributed to the quantitative data analysis, these have been described as "instrumental interviews". The coverage of these interviews is shown below and the names of those interviewed listed in Appendix C.

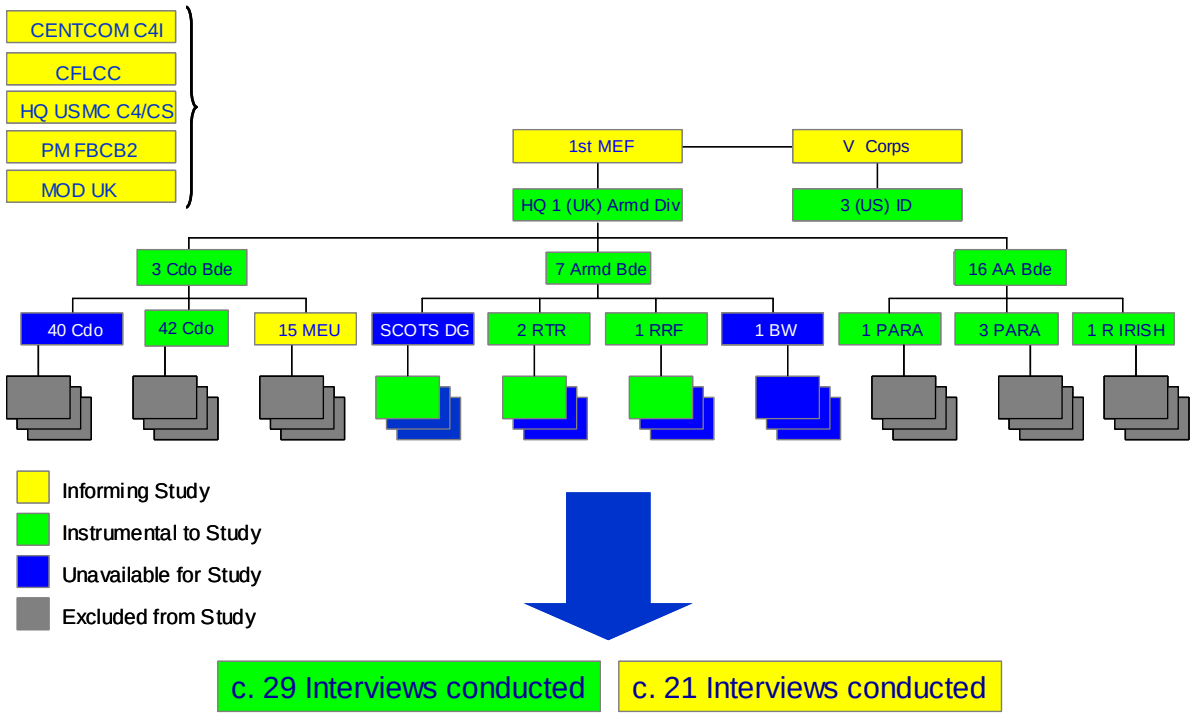


Figure 4.2.3-1 Instrumental interviews

Although the number of interviews may seem low from the perspective of statistical validity, it should be remembered that each of these was conducted with subject matter experts. In

reality, many of those concerned had exceptionally good recall of events, identifying particular operational vignettes down to the date and time – which has facilitated cross referencing with other interviews, battle logs / diaries and other records such as FBCB2/BFT archive data.

4.3 DATA COLLECTION

Although extensive use was made of AARs and a number of informing interviews, the data that was going to be used in the analysis was to be collected exclusively through a structured interview process. An interview template was developed so that all of the interviews would follow and identical sequence and use identical questions. This interview template contained five sections, the purpose of each section being:

1. Obtaining background information about the interviewee, the unit and post they served with in OIF, the nature of operations conducted, how FBCB2/BFT was deployed in that unit and details about the degree of networking prior to OIF (the baseline) and during OIF (the treatment);

2. Open questions about operations using FBCB2/BFT in OIF that enabled the interviewee to tell the story of how it had been utilized;

3. Similar open questions regarding operations prior to OIF without FBCB2/BFT;

4. Objective measures that request the interviewee quantify a number of attributes for each of the NCO CF concept areas under consideration – for operations with FBCB2/BFT and prior to OIF. In order to make this quantification less subjective, a scale was developed for each question, as shown in the example below;

5. Overall comments – which provided and opportunity to briefly summarize the overall utility of FBCB2/BFT and raise any other issues that had not been brought out in the rest of the interview.

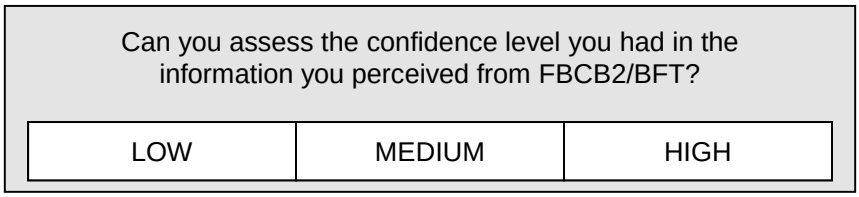


Figure 4.3-1 Example of an objective measure, with scale

In order to test and validate the draft interview template it was subjected to a number of tests as shown below. In addition to a number of iterations to refine the questions, the template was validated by means of:

- Review by a number of peer reviewers and subject matter experts;
- Conducting a small number of pilot interviews (which were only counted as informing interviews and not used in the data analysis);
- A correlation exercise against the attributes in the NCO CF to ensure adequate coverage of the concept areas being studied.

From pilot interviews with operational staff it was apparent that it would not be appropriate to try to elicit quantitative measures against each of the attributes for all of the NCO CF concept areas under consideration. Conversely, enough attributes were required for each concept area to ensure that its various dimensions were adequately explored. Therefore, a minimum of five attributes was selected for each of the concept areas being quantified. Furthermore, some aggregation of NCO CF attributes and metrics was carried out in order to simplify the interview process and the labels associated with some attributes and metrics were altered to make them more relevant to the operational staff being interviewed.

Following this review and validation process, as highlighted in Figure 4.3-2, the interview template was significantly revised – to the form shown in Appendix D.

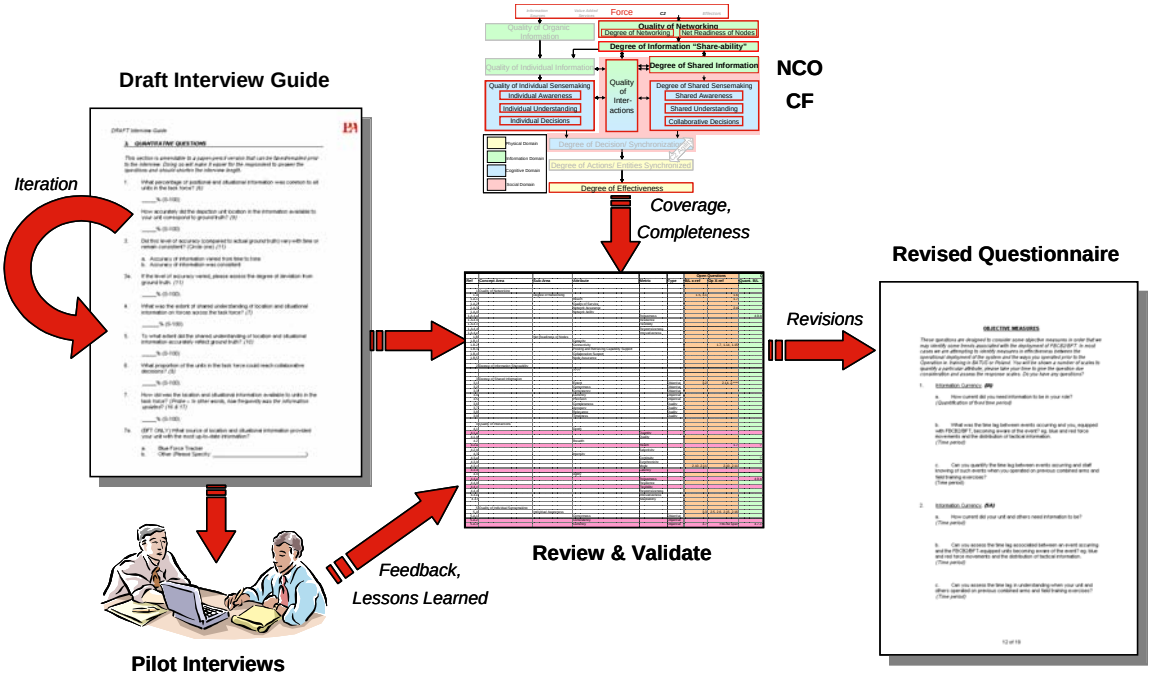


Figure 4.3-2 Interview process

Once the instrumental interviews were started the interview template was not allowed to change in order to ensure that a valid comparison could be made between all interviews conducted. However, where some questions proved ambiguous or unclear a clarification was developed and used consistently in all interviews. This consistency was further enhanced by the fact that the same researcher was present at all of the instrumental interviews and attempted to ensure that the questions were always asked in the same way.

Part way through the analysis it became clear that some of the objective measures questions could have been aligned better – so as to make the treatment answers always additive to the baseline answers, rather than sometimes being asked against an absolute scale and other times a relative one. However, since a significant number of interviews had already been conducted it was decided that it was more important to maintain consistency right the way through the interviews and develop indicative conclusions where there could have been a lack of clarity.

For the first set of instrumental interviews (HQ 1st (UK) Armd Div and 7 Armd Bde) two researchers were present for all of the interviews. During the interview the responses were written directly into the appropriate spaces on the template. These were later transcribed into electronic form for dissemination within the research team and have been archived for future reference – see Appendix C for the list of interviews conducted. In some instances voice or video recordings were made of the entire interview – assuming that the individual consented and the security procedures on the site permitted this. In these instances the recordings are also being archived alongside the relevant interview template.

4.4 DATA ANALYSIS

The instrumental interview data were utilized in two different ways. First, operational stories or vignettes were extracted which highlighted particular aspects of how operations were conducted more effectively because of FBCB2/BFT. These vignettes were categorized against the various concept areas of the NCO CF that were being considered – see Section 6. Second, the objective measures were collated and analyzed quantitatively against the attributes in the NCO CF. This analysis was carried out in a spreadsheet as described in more detail in Appendix E. Within this analysis the scores for each unit or group of units were aggregated, all results were normalized onto a zero to one scale – where higher is better – and statistics calculated for the average and range of the samples. The resulting statistics could then be presented in a number of formats – including Kiveat diagrams and average plus range for each attribute. The overall data analysis process for the objective measures is shown in Figure 4.4-1 below.

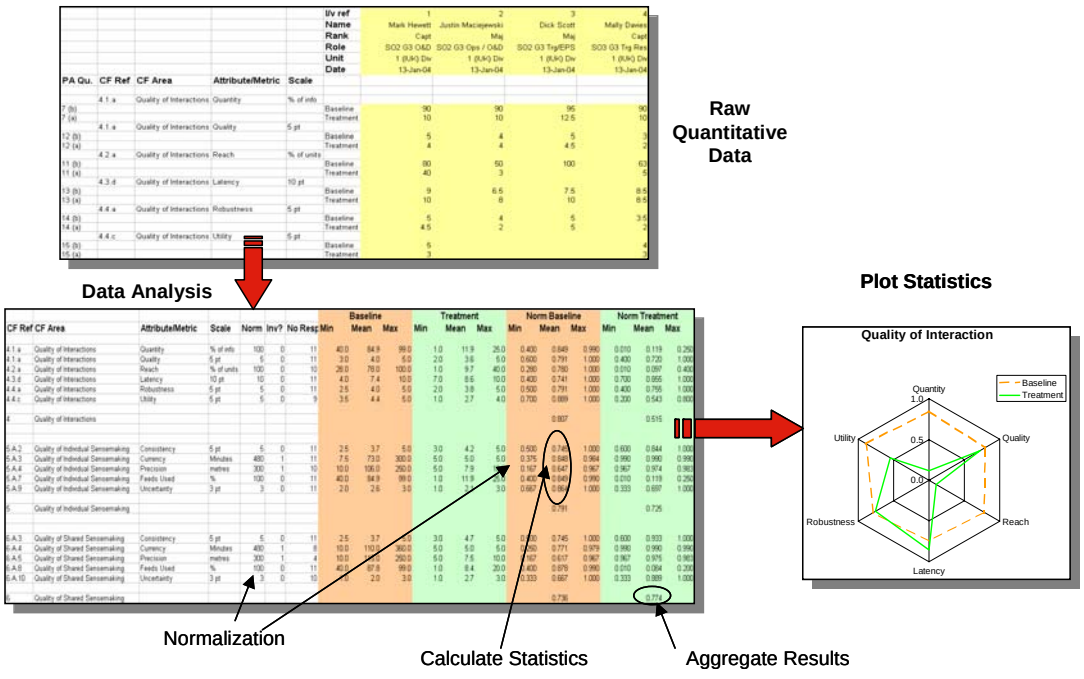


Figure 4.4-1 Overall quantitative data analysis

These quantitative measures are presented against the relevant concept areas of the NCO CF in Section 6.

5.1 GENERATING AND MEASURING VALUE

This Section addresses how a new capability (FBCB2/BFT) was exploited and how it contributed to military effect. What constitutes value in a combat environment and how may it be measured? Alberts, Garstka, Hayes and Signiori describe value as combat power derived from information superiority and NCW concepts[14]. Evans and Wurster[15] describe the information environment with the elements of richness and reach influencing the value derived. In the past, these elements have been linked, richness has been traded for reach and vice versa, however, the capacity of new information systems to handle and distribute large volumes of data between dispersed communities means that greater value may be leveraged. This is highlighted in Figure 5.1-1. Richness comprises such attributes as the fitness for use of the information, the accuracy of the information, both absolute and relative timeliness of the information for exploitation. Reach describes the degree to which information can be distributed and exploited and its accessibility throughout a network.

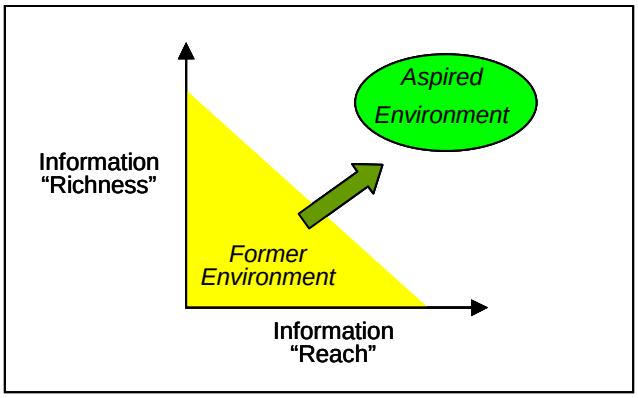


Figure 5.1-1, Creating value (adapted from Evans and Wurster)

5.2 UTILITY AS VALUE

In conducting this research, we were trying to identify if the availability of FBCB2/BFT provided the push to move "the force" towards the "aspired environment". There were a number of general findings that provided an indication on the utility of FBCB2/BFT, however, it is important to consider how the military adapted their actions to fully exploit such technology and this is addressed as "insights".

5.3 GENERAL FINDINGS FROM RESEARCH

- FBCB2/BFT provided tactical commanders and principal staff with enhanced situational awareness relative to that they had experienced in previous operations and in training for high intensity conflict.

14 David S. Alberts, John J. Garstka, Richard E. Hayes, David A. Signiori, "Understanding Information Age Warfare, August 2001.

15 Phillip B. Evans and Thomas S. Wurster, "Strategy and the New Economics of Information", Harvard Business Review (September-October 1997).

- In terms of the Joint Operational Picture (JOP), FBCB2/BFT provided information on blue forces and the environment and a very limited picture on enemy forces. Figure 5.3-1, highlights the FBCB2/BFT contribution to the JOP model shown in Section 3.

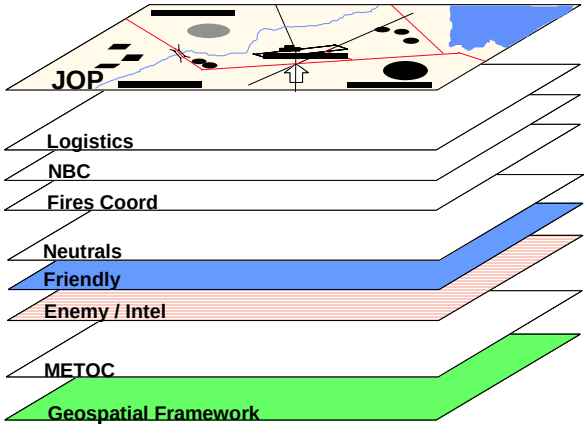


Figure 5.3-1, FBCB2/BFT Contribution to the JOP

- The system was used within the UK forces principally to augment other means for developing situational awareness. It provided a confidence check and visually zconfirmed the positions of friendly forces, allowing individuals to orient themselves swiftly to the tactical situation.
- The system was used as a tool for planning and the conduct of operations and this means of exploitation increased with the duration of the Operation.
- The deployment of FBCB2/BFT provided macro situational awareness. Units equipped with the system could see the positions of flanking units and this contributed to morale.
- The relatively close proximity of UK elements ensured that the existing VHF and trunk communications remained adequate throughout the operation. This, in part, contributed to a lack incentive among UK forces to aggressively exploit the full capabilities of FBCB2/BFT.
- Conversely, the tempo of operations and the extended lines of communications of US forces meant that existing communications architectures were inadequate to support operations. Hence, the availability of FBCB2/BFT provided an alternate means to support operations and this incentivized US forces to exploit more fully such capability.
- Most UK and US commanders and staff articulated that FBCB2/BFT has the greatest utility at company and squadron group level. They judged that deployment below this level is likely to act as a distraction. Furthermore, they noted that selected combat support and combat service support units must be equipped with the system in order that those units can support the fighting echelons effectively.
- There was consensus that FBCB2/BFT could better facilitate coalition operations though there was little evidence to suggest that there was a significant amount of US/UK operations at the tactical level (other than SOF operations that, due to their classification level, were not assessed as part of this case study).

5.4 INSIGHTS

In considering the utility of FBCB2/BFT and the contribution it made to UK and US combat effectiveness, it will be considered in two ways:

- How could existing processes and procedures be enhanced to become more efficient? This is often referred to as "doing things better."
- What new activities, procedures and processes could be generated as a result of having FBCB2/BFT? This is often referred to as "doing better things."

Some of the following examples will be explained in greater detail in Section 7 within the context of the NCO CF model.

5.4.1 "Doing things better"

There are several instances of improvements in processes and procedures by the availability of FBCB2/BFT. These have been grouped under the headings of planning, command and control agility and the ability to generate and maintain tempo:

A. PLANNING.

The ability to analyze multiple scaled raster mapping and imagery allowed commanders to:

- Undertake planning to a greater granularity than previous experience.
- Identify and communicate targets, routes, obstacles and assist in avoiding collateral damage. This was particularly beneficial when operating in urban or close environments.
- Sight support weapon systems by exploiting the digital geospatial data and terrain analysis tools within FBCB2/BFT.
- Template potential enemy defensive positions by considering enemy doctrine and capabilities and applying them to the terrain.
- Plan and debrief patrols using the system as a planning and briefing aid.
- Undertake detailed movement planning

B. COMMAND AND CONTROL AGILITY

Agility is the ability to be nimble or to have mental acuity.[16] A commander would like both; a force that can quickly exploit an opportunity and to have sufficient knowledge enable rapid decision-making. Examples of agility derived from the research are outlined within the context of the attributes of agility:[17]

- ***Responsiveness*** - Commanders and staff could orient themselves quickly to the current tactical situation by viewing FBCB2/BFT. This provided the opportunity to see the disposition of blue forces and place it in context with the current command intent.

16 Alberts and Hayes, "Power to the Edge", June 2003.

17 Alberts and Hayes, "Power to the Edge", June 2003.

- ***Flexibility*** - In association with the point above, commanders were able to turn their attention rapidly from future planning to current operations and provide command direction where and when it was most appropriate. This was because they understood that they could swiftly focus in on the current situation when required. This improved with practice as the operation progressed.
- ***Innovation*** - Commanders could make decisions through the depiction of time and space relations offered by FBCB2/BFT. They could often take decisions without the need for voice communications.
- ***Robustness*** – More rapid information flow provided commanders improved situational awareness. This allowed them not only to make decisions more rapidly, but also offered them the capability to delay making decisions, thus allowing them to make optimal decisions.
- ***Adaptation*** - Commanders could overcome limitations in the bandwidth and range of standard communication networks and use FBCB2/BFT to exercise command and control by distributing orders through its messaging capability.

C. ABILITY TO GENERATE AND MAINTAIN TEMPO

Tempo is the rate of activity. In maintaining one's own tempo, the aim is to slow that of an adversary by loading his cognitive processes and detracting from his ability to address singular challenges. Hence, one seeks to get inside an enemy's decision cycle.

- Commanders could de-conflict their maneuver with others within the battlespace. This is because commanders were able to see the movement of flanking units and other entities within the environment.
- Improved situational awareness can increase the speed of decision-making. Faster decision-making may allow a commander to direct his subordinate units more rapidly, hence create the potential for them to maneuver quicker.

5.4.2 "Doing better things"

Innovation is defined as "something newly introduced, such as a new method or device." Doing better things implies undertaking something new. FBCB2/BFT facilitated such activity in the following ways.

A. ENHANCED COMMAND AND CONTROL

3ID had been challenged in the way it exercised command and control prior to this operation. One factor was that their MSE network was limited in range to line of sight because of the communications bearers. FBCB2/BFT allowed the Division to undertake command and control on the move as it provided situational awareness of the blue force disposition in relation to the operational environment and facilitated communication beyond line of sight. The ability for this enhanced level of command and control contributed significantly to the tempo that US forces could generate and maintain.

B. SYNCHRONISATION

FBCB2/BFT provided commanders with an unprecedented view of the battlespace, enabling them to "see" beyond their own unit and formation boundaries. For large and complex operations, FBCB2/BFT was an invaluable tool. At one objective when the US forces were attempting to secure a bridge on the River Euphrates, 1 BCT was to secure the bridgehead to allow 2 BCT to be the breakout force. When forward elements of 1 BCT were reaching the objective the plan was that lead elements of 2 BCT should be four hours behind them. It should be noted that the formations were out of radio contact. In fact, elements of 2 BCT were up to eighteen hours behind according to the time and space calculations made by units of 1 BCT based on the situational awareness afforded by FBCB2/BFT. Hence, the assault on the objective became a hasty defense until such time as the operation could be conducted. This demonstrates the utility of FBCB2/BFT to allow a unit to synchronize its actions with the operational context and conform to the collective scheme of maneuver. Furthermore, it demonstrates how the 1 BCT commander was provided time to consider new courses of action.

5.5 COALITION OPERATIONS

> Whether in traditional military engagements, asymmetrical engagements, or in a variety of operations other than war, the United States will be working in coalition environments. Basic to the conduct of these operations is the ability to develop and maintain a shared perception of the situation, develop coherent plans that leverage the available resources, and execute the mission. This requires a level of information exchange, systems that can understand one another, a coalition-based planning process where all may participate, a common concept of operations, and a set of compatible procedures to carry out operations.[15]

While the focus of this study was US/UK coalition operations, during the course of our interviews - and given that we were focusing on the FBCB2/BFT as deployed at tactical levels of combat operations - within the scope of units interviewed, we were not able to establish any evidence or stories/vignettes of coalition operations that were "facilitated" through the use of FBCB2/BFT.

With the exception of initial operations involving 15MEU and 3 Cdo Brigade (until D+4), US and UK units appeared to operate as separate Divisions/Brigades at the operational and tactical levels. This was especially true as US forces advanced north towards Baghdad and UK forces remained in place. We would like to emphasize that SOF operations had the potential to demonstrate more successful leveraging of NCO capabilities by coalition operations but, due to their classified nature, were not within the scope of this case study.

Interviews with personnel from 1 (UK) Armd Div highlighted that planning that had been undertaken prior to crossing the line of departure regarding the use of FBCB2/BFT had not resulted in the system being used as agreed between unit commanders. 7 Armd Bde was due to conduct a relief in place with units from 1 MARDIV (5 and 7 RCT) which was to be coordinated with the use of FBCB2/BFT. It should be noted that for both the Marines and UK forces, this was their first experience with FBCB2/BFT. Apparently, when the US forces were engaged by Iraqi forces south-west of Baghdad, the system was disregarded and the relief in place was conducted through the more familiar use of liaison officers on the ground. An interview with the former Commander of 15 MEU underscored problems related to the FBCB2/BFT (only one unit was made available to 15MEU) – as well as MDACT/C2PC. As a result, the Marines abandoned use of this equipment during operations.

Again, it should be noted that based on "informing" interviews at higher levels (CENTCOM, CFLCC and V Corps), the FBCB2/BFT contributed to significantly improved individual and shared awareness not achieved in previous combat operations; but, evidence of this is based on a limited number of interviews and can not be substantiated further through this study. It is highly recommended that a study of this type at these levels be undertaken. At the time of this writing, the U.S. Army War College is conducting a case study that addresses these operational levels within the 3ID and V Corps but not necessarily for all entities within the theater of operation.

As is documented in the instrumental interviews, overall situational awareness of blue forces for those who had access to and used BFT was unprecedented, but of limited utility for the 1 UK Armoured Division because of the different missions US and UK forces were given.

Based on all our interviews, both instrumental and informing, we have made the following observations regarding the contribution of FBCB2/BFT to coalition operations:

- FBCB2/BFT provided an incremental, although somewhat limited, contribution to improved coalition operations by providing units situational awareness of one another (i.e. between coalition forces).
- The limited deployment, training, usage and operation of FBCB2/BFT with the UK units limited its contribution to overall situational awareness
- Perception of non-usage of FBCB2/BFT by US forces (e.g. 1 MEF) in interfacing with UK forces discouraged subsequent usage of the systems between coalition forces
- Anecdotally, the greater benefits appeared to be at the operational and strategic levels of command where blue force feeds from multiple sources were aggregated to provided a coalition COP – according to interviews with CENTCOM and CFLCC

5.6 FIELDING TRANSFORMATION

It was clear from the case study firstly that there were significant differences between the effectiveness of FBCB2/BFT deployment within US and UK forces and secondly there was significantly lower effectiveness than might be expected from an analysis of the available functionality. Indeed, many interviewees talked of the potential of the system although they had not been able to exploit more than a small part of this during OIF. An example of the difference in effectiveness delivered through FBCB2/BFT by the US and UK forces, is shown in Figure 5.6-1.

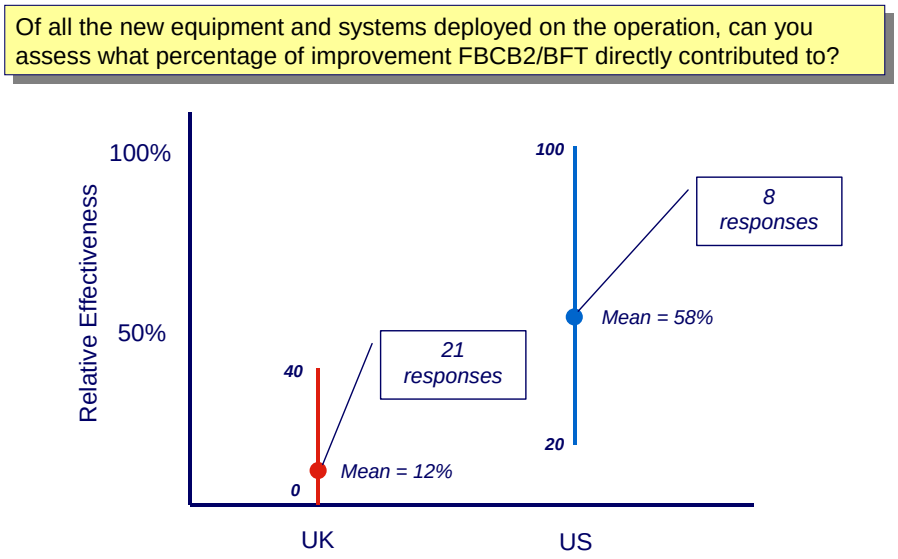


Figure 5.6-1 Variance in perceived relative effectiveness

Although it could be that the increased effectiveness perceived by the US forces relative to the UK was due entirely to the increased deployment density, this was not the only difference that existed between the forces. Some of the other differences between the forces are discussed below.

5.6.1 Propensity for change

The UK land forces have largely used paper charts and voice communications as their primary means of gaining situational awareness for many years – the existing combat net radio having been deployed for around 30 years. As a result, their tactics, techniques and procedures (TTPs) have been thoroughly optimized for this environment and everyone is well trained and experienced in war-fighting this way. Consequently there is little incentive to change and indeed a fear that new and unproven systems may reduce combat effectiveness - at least in the short-term while its intricacies are mastered.

In contrast, the US land forces deployed in OIF had more familiarity with computer-based systems – having already used tactical intranets, such as SIPRNET, to provide some INTEL and situational awareness for some time. Therefore, their TTPs are likely to have evolved somewhat towards those needed for digital situational awareness. This is likely to have made them more amenable to adapting to using FBCB2/BFT for a significant proportion of their situational awareness needs during OIF.

This difference in propensity to change can be summarized in the technology lifecycle chart in Figure 5.6.1-1. Due to their earlier exposure to the next technology wave (i.e. digital information that supports SA, such as tactical intranet and FBCB2/BFT) a larger proportion of the US forces are happy to migrate to this technology. By comparison, the bulk of the UK forces are still happiest with their proven technology and it is only a relatively small number who are prepared to try the new technology – largely in a tentative and experimental way. These individuals are often labeled "innovators" and "early adopters" in marketing terms.

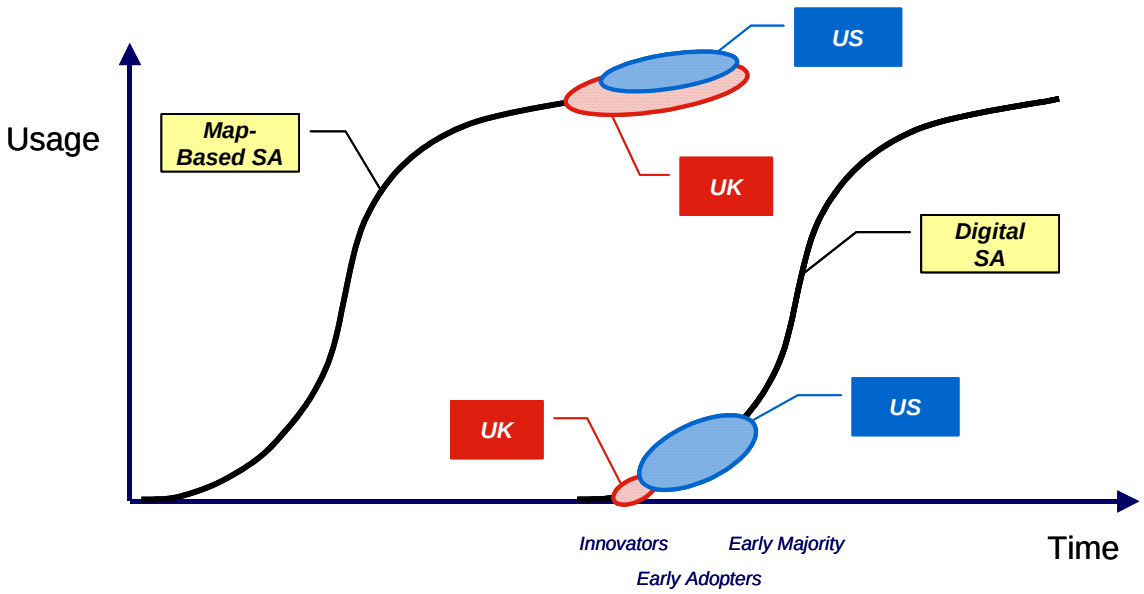


Figure 5.6.1-1 US and UK Adoption of FBCB2/BFT

5.6.2 Communications needs

Most of the UK force's operations during OIF only involved short distances (around 70km), with each brigade only being spread over a very limited geographic area. Given this dispersion, the line of sight based combat net radios provided robust communications throughout the operation. Also, because of the use of commercial L-band satellite communications for data transmission, the UK forces had restricted the messaging capability to the unclassified level and encouraged the use of this capability only *in extremis*. Since relatively little was known about the way in which FBCB2/BFT worked (transmission power, etc.), some of the personnel interviewed highlighted emission control concerns early in the conflict that may have limited the extent to which it was used. Therefore, there were no compelling reasons for UK forces to use the messaging and reporting capabilities of FBCB2/BFT and some concerns as to why they should be avoided for emission control and operational security reasons.

By contrast, the US forces operated over significantly greater distances and more importantly individual brigades were dispersed over significantly larger areas. In several instances during the advance towards Baghdad, units were operating over an area of up to 200km – well beyond the normal 10~20 kilometers from Division. This meant that for periods of several

days, some units were beyond the range of their line of sight radio networks and they had to rely upon the messaging and reporting capabilities within FBCB2/BFT in order to remain in contact.

The significant difference in the distances involved in UK and US operations can be seen in the map extract in Figure 5.6.2-1.

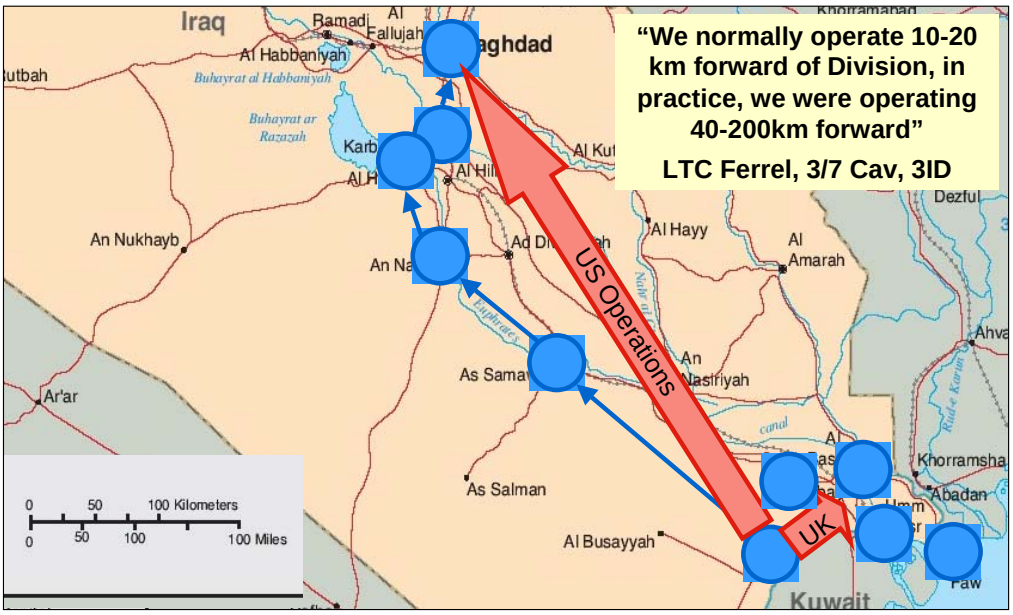


Figure 5.6.2-1 Distance involved in US vs. UK operation

5.6.3 Lines of development

In order to effectively field a mission capability package normally one would seek a high level of readiness across all of the lines of development (i.e. DOTMLPF). However, since FBCB2/BFT was fielded as an urgent operational requirement relatively close to crossing the line of departure, there was not time to achieve adequate readiness in all the lines of development – which may go some way to explaining why the potential of the system was not fully utilized. Furthermore, there were significant differences in the maturity of the different lines of development between UK and US forces, as shown below – which may explain some of the differences in relative effectiveness through FBCB2/BFT between the UK and US.

Looking at each of the lines of development and their potential impact separately:

- **Doctrine** – neither US (at least in the case of 3ID) nor UK forces had developed specific doctrine for the exploitation of digital SA systems such as FBCB2/BFT, However, with their previous experience of tactical intranet the TTPs for US forces were likely to be more adaptable to FBCB2/BFT than would be the case for UK TTPs. Also, UK guidance on emission controls and operational security could have limited the ability of UK forces to fully exploit FBCB2/BFT.

- **Organization** – the UK forces had little guidance as to which vehicles to deploy FBCB2/BFT in and commanders had little knowledge of its capability. As a consequence the deployment strategy varied considerably by brigade. For example, some units opted to deploy the systems in the command vehicles – which didn't always represent the unit's center of mass (e.g. when commanders were being briefed at the higher HQ). Similarly the operation of FBCB2/BFT was in some cases left to signals staff, while in others commanders or G3 staff took a more active interest. This lack of consistency in the concept of employment can be largely attributed to the hasty deployment of FBCB2/BFT – in some cases as little as 5 days before crossing the line of departure, this in a period when there were many other operational imperatives such as up-armoring and live-firing.

  By comparison, the US deployment appears to have been thought through a little more thoroughly and commanders were more engaged in the employment of FBCB2/BFT. However, the organizational line of development still fell somewhat short of that which would normally be expected when fielding a complex new operational system such as FBCB2/BFT.

- **Training** – neither UK nor US forces had anything like the degree of training normally associated with fielding a complex new system. In the UK forces, training was as little as an hour or two, was limited to the basics of operating the system, was only given in the last week or two before crossing the line of departure and was often limited to junior signals staff.

  In contrast the US forces had longer to train with FBCB2/BFT, trained more personnel and included a "key leader brief" for company commanders to explain the need to evolve their TTPs to fully utilize FBCB2/BFT. However, even US forces still had little time to develop TTPs and practice them before crossing the line of departure.

- **Materiel** – the deployment density of FBCB2/BFT available in OIF was somewhat lower than the ideal in most units and only offered a center of mass approximation down to battalion level and in a few cases company. However, the deployment density within US forces (3ID) was about three times greater than in equivalent UK forces and may have been somewhat closer to the critical mass at which a blue force tracker really becomes useful.

  The fit of FBCB2/BFT in most vehicles was also developed at a very late stage of the deployment and was in many cases less than ideal – for instance, commanders could not see the FBCB2/BFT display when they had their heads out of the vehicle. In other cases elements of the system were positioned in locations that were prone to damage. In-theater technical support for FBCB2/BFT was also severely limited and some unserviceable systems could not be repaired during the period of high intensity conflict.

- **Leadership** – it undoubtedly helped that the use of FBCB2/BFT was mandated through the US chain of command. However, there was far less leadership direction within UK forces and it is likely that this contributed to the lower degree of use.

- **Personnel** – as already discussed above, it is believed that US personnel had a greater acceptance of the new technology. Furthermore, the high deployment density within US forces will have created conditions that were closer to a critical mass for deployment and made the system more relevant and useful.

- **Facilities** – not applicable.

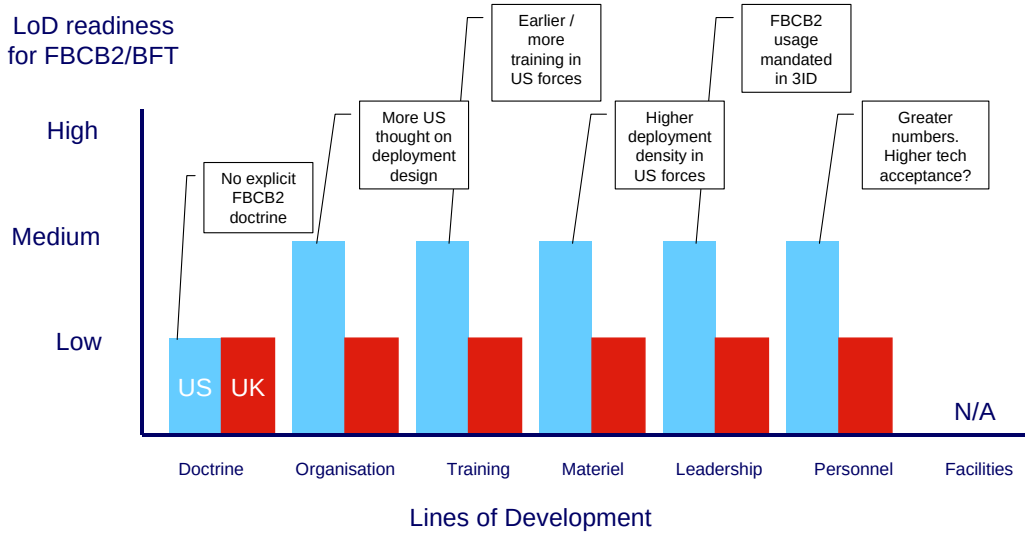
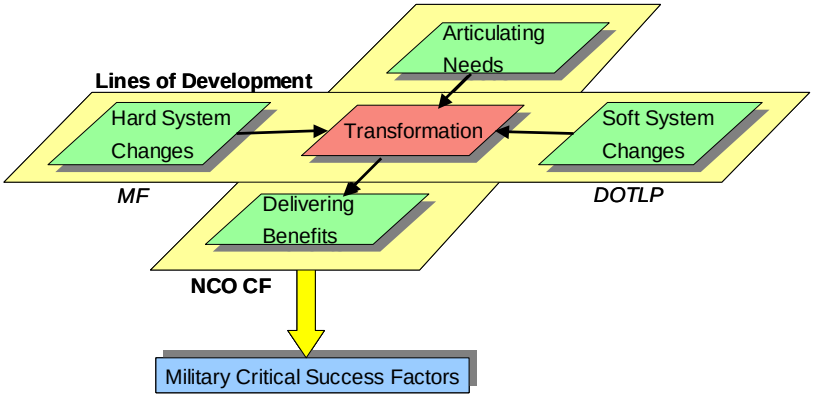


Figure 5.6.3-1 US and UK lines of development

In summary, the inability to fully exploit the system's potential can largely be attributed to the hurried and incomplete fielding of the FBCB2/BFT as an urgent operational requirement over a period of just a few weeks prior to crossing the line of departure. Similarly, the difference in relative effectiveness for FBCB2/BFT seen between the UK and US forces can largely be attributed to the differing maturity levels between their respective lines of development. Hence, it could be concluded that in order to fully realize the expected benefits of a transformational change program it is vital to ensure that all of the lines of development are adequately addressed – including the soft aspects - and sufficient time is allowed for the development of TTPs and experience in using new systems before attempting to utilize them operationally. These are aspects that although mentioned in relation to the NCO conceptual framework, probably need to be emphasized more explicitly, as shown in the model in Figure 5.6.3-2 below that places transformation at the intersection of the NCO conceptual framework and the DOTMLPF model.

Figure 5.6.3-2 Intersection of NCO CF and DOTMLPF



6. INTERPRETATION AND ANALYSIS OF FINDINGS

6.1 METHOD

The interpretation and analysis of the findings has been undertaken within the context provided by the NCO Conceptual Framework. The research undertaken was to identify measures of attributes in each of the following top-level concepts:

- The degree of networking
- The quality of individual sensemaking
- The quality of interactions
- The degree of effectiveness

These top-level concepts are shown graphically, within the context of the Framework in Figure 6.1-1. As stated earlier in this report regarding the approach to the research, a mix of qualitative and quantitative questions was posed to interviewees that could be correlated with the CF model. In order to constrain the research, specific attributes were assessed for the quality of individual sensemaking, the quality of interactions and the degree of effectiveness, specifically:

- Consistency of information
- Currency of information
- Precision of information
- Number of information sources exploited
- Confidence in information

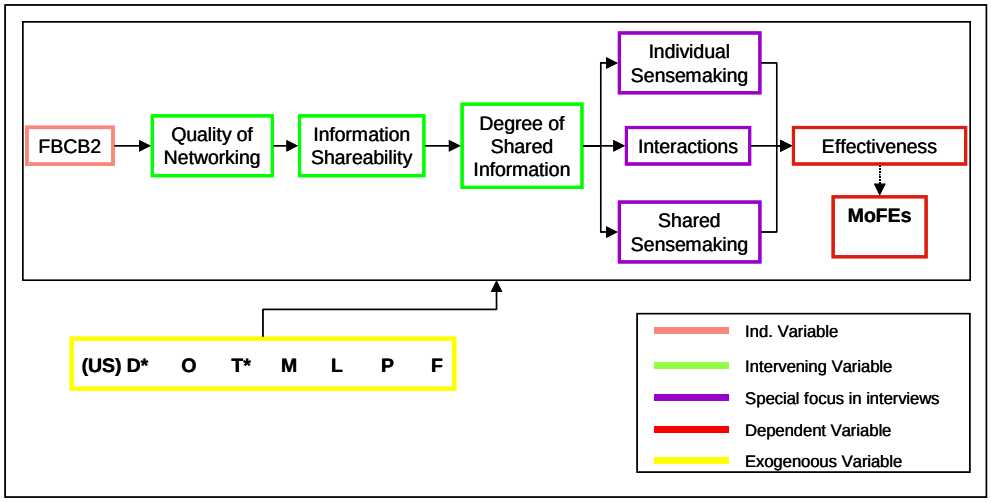


Figure 6.1-1, NCO Conceptual Framework and Areas of Research

6.2 A SYNOPSIS OF NETWORKING

6.2.1 Description of Networks

In order to assess individual and collective situational awareness it is necessary to quantify the networks available to UK and US military personnel for the passage of information and, hence, the perception of situational awareness. Both the UK and US operated VHF/FM radio command nets; the UK used CLANSMAN radios that are predominantly insecure below formation level. Insecure communications were augmented by limited secure trunk communications and TacSat. The US operated with SINCGARS radios that provided secure communication down to squad level. FBCB2/BFT was superimposed on these radio nets to enhance situational awareness.

6.2.2 UK forces prior to deployment

UK forces operate a combination of secure and insecure communication systems. Routinely, command and control would be exercised through Ptarmigan secure trunk communications and secure and insecure combat net radio (Clansman CNR). Ptarmigan predominates at formation level and a single link generally exists down to battlegroups. Insecure voice communications is the vehicle for command and control at battlegroup level and below where messaging is encoded prior to transmission. Formation headquarters also have the Army Tactical Command System (ATacCS) available to them that provides a suite of office tools and a data messaging capability.

The UK communication architecture is extremely “stovepiped,” operating vertically within the chain of command. Consequently, the following situation exists:

- Company and squadron groups operate an internal command net and their HQs will also operate on the battlegroup command net. Consequently, there is little lateral communication between company and squadron groups.
- Battlegroups operate their own internal command net and the battlegroup HQ is on the brigade command net. There is, therefore, little communication between battlegroups and none between adjacent company and squadron groups in adjacent battlegroups.
- Brigades operate their own command net and the brigade HQ will operate on the divisional command net. There is little communication between brigades and none between battlegroups in adjacent brigades.

This situation is suggestive of a hierarchical structure that suggests two weaknesses:

- The time required to transmit information through the hierarchy is lengthy due to the extended vertical chains.
- The information paths are vulnerable; if one superior node is damaged and cannot process information, the subordinate nodes are starved of information.

The structure is shown schematically in Figure 6.2.2-1.

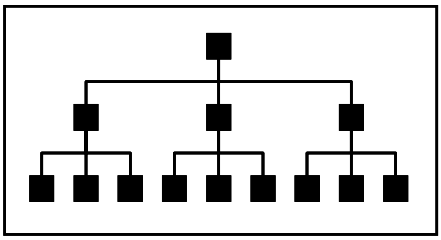


Figure 6.2.2-1, The UK Communications Structure

What is the effect of such an architecture? Situational awareness and general contextual information may be derived through formal processes such as orders prior to an operation, whereby commanders and principal staff share information, plan upon a common understanding and brief their subordinates accordingly. Once operations start, routine situational awareness is gleaned from the radio which provides a context to an individual which is then fused with knowledge to derive understanding through which one may orient decisions and actions.

Within 1 (UK) Armd Div, situational awareness can be maintained within the immediate environment, however, it is less easy to maintain in the wider perspective. Hence, company or squadron commanders within different units or formations sharing a common boundary are unlikely to know the detailed situation in the neighboring sub-units' area of operations. The same may be said for battlegroup and brigade commanders. This results in difficulties in maintaining shared awareness within the same locality and, thus, actions cannot be synchronized. A lack of synchronization will impact upon operational tempo and the ability to maneuver and engage for greatest affect.

6.2.3 UK forces following deployment

Following deployment, the UK had a number of augmentations to their communications architecture described above. The Joint Operational Command System (JOCS)[18] was deployed to all formation HQs providing a data link and messaging capability between the UK Permanent Joint Headquarters (PJHQ) and all deployed formation headquarters, however, it provided minimal situational awareness at the lower operational level of command. CENTRICS-X, a coalition information system, was deployed in all formation headquarters providing messaging connectivity. SIPRNET, a US eyes only, information system was also deployed within UK formation headquarters, operated by US Foreign Disclosure Officers, for UK access to classified US material.

Tactical satellite (TacSat) communications were deployed within 3 Cdo Bde. The Brigade was provided 2 TacSat channels that provided secure voice and data communications down to company group level. This capability provided the Brigade with increased internal situational awareness; however, it had limited external situational awareness due to insufficient connectivity.

There were a number of satellite telephones distributed within 1 (UK) Armd Div. Some of these telephones allowed secure speech, however, their deployment was not systematic and this research has not found that they had a significant impact on command and control.

18 JOCS has been deployed on formation field training exercises but is not a routine feature of brigade communications in peacetime.

FBCB2/BFT was deployed in 1 (UK) Armd Div. The deployment of the forty-seven systems fielded down to major unit level within 3 Cdo and 16 Air Asslt Bdes, and down to company and squadron group level in 7 Armd Bde, offered a capability for improved situational awareness. Consequently, this could overcome some of the inadequacies of "stove-piped" communications. In contrast to radio communications, FBCB2/BFT, operating on L-band, provides communications vertically and horizontally through national and coalition chains of command. If the system is serviceable, a user could see the position of other users and communicate through tactical email. The effect of these enhancements was to add some horizontal connectivity at the lower levels of the hierarchical construct, akin to Figure 6.2.3-1.

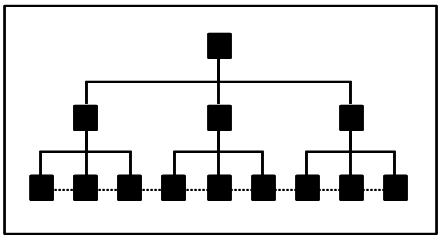


Figure 6.2.3-1, Flattened Communications Hierarchy with FBCB2/BFT and TacSat

6.2.4 US forces prior to deployment

3ID exercised command and control through a Mobile Subscriber Equipment (MSE) network that provided Battlefield Operating Systems (BOS). The BOS carried common and functional applications for the planning and execution of operations. This capability was deployed to formation (BCT) level. The major limitation of the capability was the static nature through which command and control was exercised. Due to the limitations of the communications bearers operating by line of sight, headquarters had to be static and in relatively close proximity of each other, generally less than 10km apart. Some elements of the BOS were provided at major unit (task force) level, notably All Source Analysis System (Light) (ASAS (Lt)) and Advanced Field Artillery Tactical Data System (AFATDS), intelligence and fire planning systems respectively.

The US already had a radio network that allowed secure communications across unit and formation boundaries: Single Channel Ground and Airborne Radio System (SINCGARS). 3ID units also had the Enhanced Position Location Reporting System (EPLRS) radio systems, though this was considered dysfunctional[19] and the personnel interviewed during this project articulated that their units deployed only with SINCGARS. Consequently, 3ID had a partially networked force constrained by the distance over which their communication networks could operate. It may be represented by the schematic in Figure 6.2.4-1.

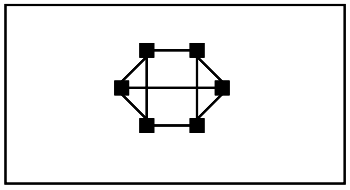


Figure 6.2.4-1, US Partial Networked Force Pre-Deployment

19 A comment made by several interviewees.

6.2.5 US forces following deployment

The major enhancement to the capability for command and control in 3ID was the deployment of FBCB2/BFT.[20] The Division received approximately 150 systems that allowed its deployment to company level. Prior to this deployment, the Division had been constrained by range, both for the BOS and for the SINCGARS FM radios. However, the introduction of satellite enabled FBCB2/BFT provided, as discussed earlier, supported situational awareness and offered a means of communications beyond line of sight. Indeed, FBCB2/BFT became the primary method for passing fragmentary orders (FRAGOs) during offensive operations.[21]

The after action review produced by 3ID[22] stated: "The consensus from the Division was that FBCB2/BFT worked phenomenally well. The ability of our Army to digitally communicate without the constraint of terrain and to track our forces at near-real-time is an awesome ability that we must provide our units in order to remain a step ahead of the threat, regardless of symmetry".[23]

3ID also received approximately fifty single channel TacSat radios, twenty-nine Harris HF radios and Iridium and Thoria telephones. The Divisional command net was on TacSat while HF, procured at late notice, served as a back-up but was not required. The Division had the opportunity to exercise with these radios prior to the operation, hence, were proficient in exploiting the capabilities of the equipment. The TacSat net proved to be essential for operations, particularly over the extended lines of communication the Division was operating over. The telephones that were deployed are not thought to have had a significant impact on 3ID offensive operations. The impact of the combination of the deployment of FBCB2/BFT and TacSat provided a significant contribution to the aspiration of fielding a robustly networked force represented in Figure 6.2.5-1.

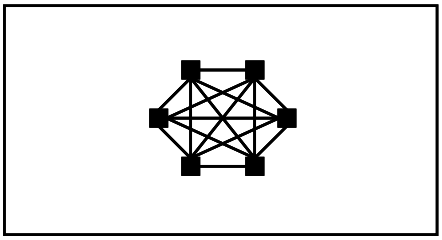


Figure 6.2.5-1, the Robustly Networked Force

The Division also had access to the Global Command and Control System (GCCS). FBCB2/BFT provided a significant information feed to this system that aggregated a number of sources to display the common operational picture (COP). CFLCC maintained a recognized land picture that was aggregated with the picture from C2PC (see Figure 6.2.5-2) in 1st MEF. The system is shown in Figure 6.2.5-3.

20 LTC Bayer, G3 3ID.

21 LTC Bayer, G3 3ID.

22 Operation IRAQI FREEDOM, 3ID After Action Report (Draft), 12 May 2003.

23 Operation IRAQI FREEDOM, 3ID After Action Report (Draft), 12 May 2003, Page 8-2.

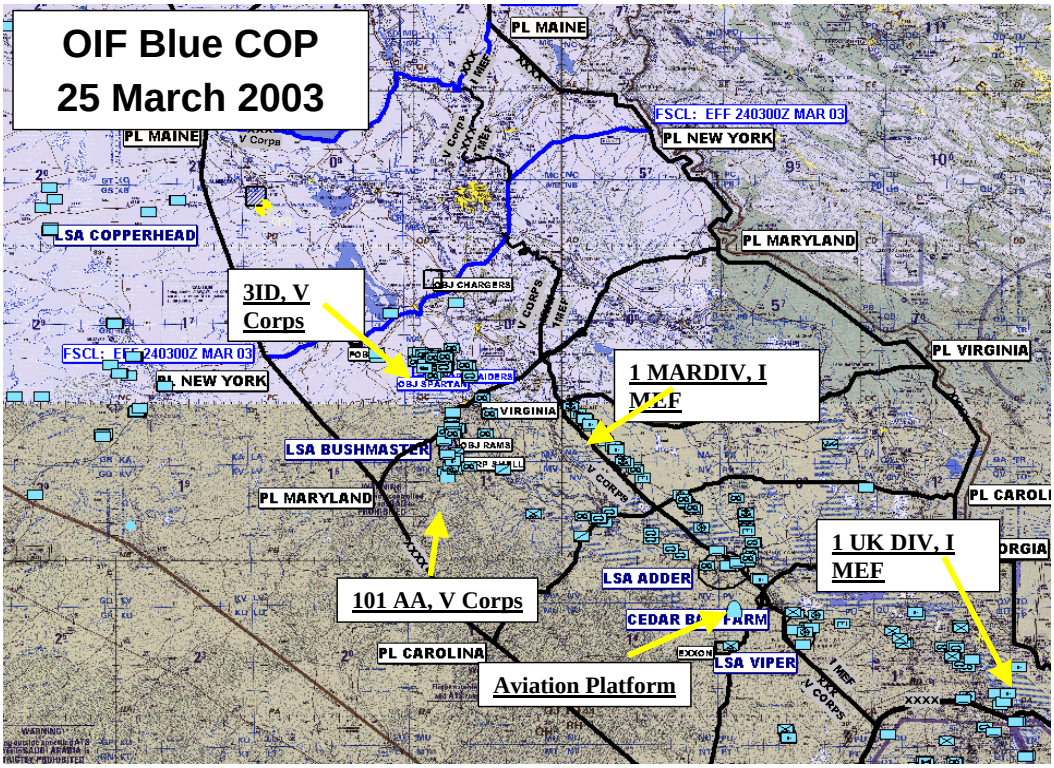


Figure 6.2.5-2, C2PC Picture with FBCB2-BFT generated icons

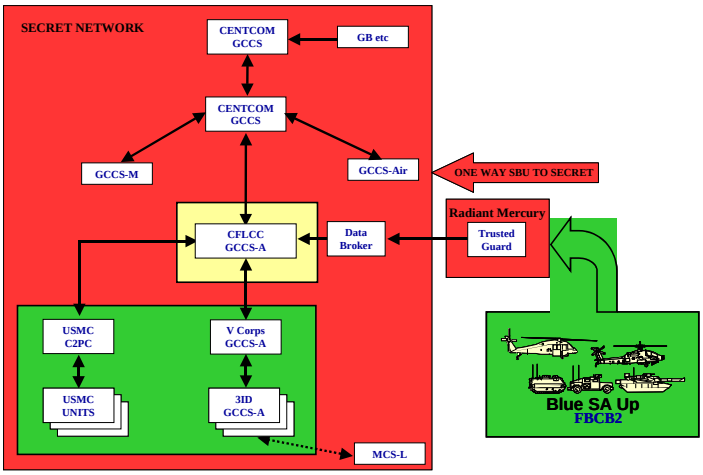


Figure 6.2.5-3, Data Aggregation to Form the Common Operational Picture

6.2.6 The quality of networking

The quality of networking encompasses both the degree of networking and the net readiness of nodes. During Operation TELIC/Iraqi Freedom, at the tactical level of command, the UK and the US networks were different and, therefore, their relative values cannot be compared directly. A common feature of both the UK and US augmented networks was that FBCB2/BFT

provided a capability for beyond line-of-sight connectivity to disseminate data and provide access to raster maps and imagery.

Each national network is described below highlighting some of the attributes of the quality of networking:

A. UK NETWORK

i. Reach

The UK VHF radio network allowed a high degree of information sharing at the local level, contributing to localized situational awareness; however, it did not provide routine access to wider contextual information. The augmentation of this network with FBCB2/BFT, utilizing L-band satellite communications, certainly provided the potential for greater reach, in terms of cutting sideways through the chain of command to provide situational awareness left, right, forward and back.

ii. Connectivity

The reach of the network was limited by the number of nodes – 47 nodes only allowed access to the network at formation and major unit level within the Division, less in 7 Armd Bde where access to the FBCB2/BFT network was deployed to company and squadron group level.

iii. Quality of Service

The quality of service of the VHF radio network was good given the geographic proximity of the UK forces. The network was robust and available most of the time; hence there was a high degree of network assurance. Similarly, the quality of the service of the FBCB2/BFT was generally good, though there were instances of damage to essential components of the system, notably GPS antennae, due to their ill-positioning as a result of rapid fitting. The richness of the information gleaned from FBCB2/BFT was not as great as through the VHF Radio network as UK forces were directed not to use the messaging system except *in extremis* due to concerns over emissions control. Furthermore, there was no use of the ability to create and distribute graphics.

B. US NETWORK

i. Reach

The US FM radio network became inoperable as the forces started operating beyond line of sight in order to generate and maintain tempo. The FBCB2/BFT network provided a means for command and control and offered the reach required to conduct such operations.

ii. Connectivity

The reach of the FBCB2/BFT system was significantly better than that available to UK forces. 3ID received approximately 150 systems that provided a deployed capability to all maneuver companies.

iii. Quality of Service

The richness of the SINCGARS radio network was similarly constrained by distance and the FBCB2/BFT compensated for this deficiency to provide a robust network available almost all of the time. The US forces made full use of the messaging capability of FBCB2/BFT and regularly used the system for the passage of orders and the distribution of tactical schematics, hence, the richness of the information passed over the network was equal to and often better than that passed over the radio network.

C. SUMMARY

The comparison is networks with the addition of FBCB2/BFT, relative to prior to the deployment may be summarized as follows:

Before	***After***
VHF/FM Line-of-sight radio network	VHF/FM Line-of-sight radio network Beyond line-of-sight network
Voice	Voice Data
Paper maps	Multiple scale raster maps Imagery

6.3 OTHER INTERVENING VARIABLES

As discussed in section 4.1, these variables were reviewed only at a high level:

6.3.1 Degree of information "share-ability"

As discussed in section 4.1, "share-ability" was not a NCO CF concept area that was examined through detailed interviews; instead it was addressed only at a high-level by looking at the FBCB2/BFT functionality, information flows and architectures available before and after treatment.

The main aspects of information share-ability through FBCB2/BFT have been discussed in section 6.2 on the Quality of Networking. Specifically, the addition of FBCB2/BFT in the treatment provided: automatic update of individual and collective position blue force positions, messaging, the potential to allow sharing of boundaries and other overlays and it provided a readily assimilated visual presentation of situational awareness – particularly for blue assets and the environment, though there was no credible "red picture".

As articulated in 6.2.3, these capabilities were not always fully utilized in OIF. Table 6.3.1 highlights the difference in information sharing prior to and after the deployment of FBCB2/BFT.

Before	***After***
Manual updates	Automatic updates
	Messaging – including standard reports and free-text
	Sharing of boundaries / graphics
	Visual SA of blue assets

Table 6.3.1, Information "Share-ability"

6.3.2 Quality of individual information

As discussed in section 4.1, this was not a NCO CF concept area that was examined through detailed interviews; instead it was examined only at a high-level by looking at the FBCB2/BFT functionality, information flows and architectures available before and after treatment.

The additional aspects of individual information added by the inclusion of FBCB2/BFT in OIF were: the provision of real-time information on own position that was accurate to within a few meters, availability of multi-scale mapping and imagery, an update on all FBCB2/BFT equipped blue assets within 5 minutes or 800 meters and the ability to overlay all of these elements in a single graphical display. The differences in the quality of individual information are summarized in Table 6.3.2.

Before	***After***
Near real-time warnings	Real time information on own position (+/- 10m)
Routine reporting 1~2 hours	Multi-scale mapping and imagery
	Blue asset update within 5 mins / 800m

Table 6.3.2, Differences in the Quality of Individual Information

6.3.3 Degree of shared information

As discussed in section 4.1, this was not a NCO CF concept area that was examined through detailed interviews; instead it was examined only at a high-level by looking at the FBCB2/BFT functionality, information flows and architectures available before and after treatment.

The additional aspects of shared information added by the inclusion of FBCB2/BFT in OIF were: the availability of an update on all FBCB2/BFT equipped blue assets within 5 minutes or 800 meters, the capability to message each other beyond the range of line of sight communication links, and the potential for sharing of boundaries and other overlays graphically. The differences in the degree of shared information are summarized in Table 6.3.3.

Again these were capabilities that were not always fully utilized in OIF.

Before	***After***
Near real-time warnings	Blue asset update within 5 mins / 800m
Routine reporting 1~2 hours	BLOS messaging capability
Verbal relay of boundaries	Sharing of boundaries and overlays graphically

Table 6.3.3, Differences in the Degree of Shared Information

6.4 INDIVIDUAL SENSEMAKING

Sensemaking is the ability to frame events in the physical environment and fuse it with prior learning and understanding. It is often considered in terms of *awareness*, the process of combining information and knowledge and *understanding*, the process whereby one may draw inferences about a situation and predict possible consequences. Sensemaking is a socio-cognitive process and, as such, is greatly influenced by the interactions within social networks. Therefore, sensemaking will vary between individuals.

FBCB2/BFT provided the capability to enhance individuals' sensemaking significantly. The ability to analyze the operational and tactical environment to such a high resolution, with routine access to multiple-scaled maps and imagery, provided the capability to undertake a number of tasks in a more effective way. The following vignettes, derived from interviews with unit personnel, provide examples of how this impacted the awareness of individuals.

- 2 Royal Tank Regiment (RTR) battlegroup used the imagery extensively in order analyze and plan routes for maneuver for the Challenger 2 main battle tank. The method in which this was conducted is that commanders could survey an area of interest at small scale and then focus in on specific areas at far greater scale. Thereafter, imagery was used to identify likely obstacles such as berms and ditches and these could even be measured to define what impact they were likely to have on the movement of a squadron of tanks. The ability to undertake this type of planning, particularly, for urban and suburban areas meant that maneuver could be undertaken more rapidly, knowing where the likely impediments.

- Similarly, 2 RTR used a combination of the satellite imagery and the positioning capability in FBCB2/BFT to identify targets for urban raids. During operations in Az Zubayr and Basrah, information was provided on likely insurgent operating bases. These were, generally, houses in urban neighborhoods. Using FBCB2/BFT these locations could be pinpointed and could be reached rapidly using FBCB2/BFT for navigation. This achieved surprise and also minimized the impact of collateral damage through misinterpreting information.

- 3 PARA used the geospatial data within FBCB2/BFT for the sighting of support weapons, specifically the Milan anti-tank guided weapon and the General Purpose machine (Sustained Fire) (GPMG(SF)). Traditionally, weapons are sighted by analyzing a map for likely effective positions and then confirmed by a ground reconnaissance. The combination of the maps, imagery and digital terrain elevation data (DTED) allowed for a far more detailed analysis of the ground to confirm arcs of fire. This minimized the amount of time required for ground reconnaissance.

- A company commander in the 1st Battalion, Royal Regiment of Fusiliers (1 RRF) battlegroup used FBCB2/BFT to de-conflict the movement of his company group in order to get to the line of departure for a company group attack. At the time of this movement it was approximately D+2 and south-east Iraq was congested with US and UK forces. The coordination of movement was challenging. In this vignette, the company group had to cross a main supply route aligned perpendicular to their axis of advance. The route was heavily trafficked and crossing a battlegroup which the company group was part of was going to prove difficult. The company commander used FBCB2/BFT to identify a gap in the traffic on the main supply route and then coordinated the move of his sub-unit, comprising approximately 20 armored vehicles. This allowed him to generate tempo which resulted in the objective being seized 12 hours before the other battlegroup objectives were seized.

- Commanders used FBCB2/BFT to quickly orientate themselves to the current operational or tactical situation. The commander of 1 BCT described how his role demanded him to direct and monitor current operations while considering future plans. This means that one may quickly need to divert attention from planning to the current situation if demanded. 1 BCT's commander reported that looking at the FBCB2/BFT screen in the context of the shared command intent allowed him to make sense of the current situation far quicker than he had been able to do prior to having FBCB2/BFT. He also said that he became more adept at changing focus the more he became proficient with the capabilities of FBCB2/BFT.

- US commanders in particular, where FBCB2/BFT was deployed in greater density, said that they were able to glean information quicker through FBCB2/BFT. This is in the context of the challenge of radio communications over the distances in which they operated. Quicker access to information allowed them either to make decisions more rapidly or delay decision-making. Quicker decision-making facilitated the delivery of orders in a shorter timeframe, reducing movement time or allowing more time for preparation and rehearsals. The ability to delay decision-making often provided the ability to create the optimal effect in time and space. The commander of 3/69 Task Force described how at the end of a three-day period of offensive action and maneuver, that plans and orders for the attack on Baghdad International Airport were distributed by FBCB2/BFT to maintain the momentum of the advance and achieve the maximum disruption of enemy forces.

In the analysis of the treatment, the access to FBCB2/BFT, relative to the baseline, previous operations and exercises, the following was found:

- The treatment scored marginally better for consistency than the baseline. This was due to the automated positioning that eliminated human error in sending and plotting accurate grid references. Additionally, orders could be sent rather than transcribed through voice communications and graphical information could be distributed to inform units of important control features. It should be noted that the consistency of information only applies to the disposition of forces with 1 (UK) Armd Div as they did not use the system routinely for the passage of any other information.

- The treatment scored better than baseline for currency. Though information could be sent immediately over a radio, it requires units to be in range and FBCB2/BFT would allow immediate data messaging. More importantly, FBCB2/BFT automatically updated the

positions of units with the system every 5 minutes or if the asset had moved 800m or more. This update rate was far greater than normal reporting cycles within the UK and US forces. Again, the currency of information only applies to positioning for UK forces.

- The precision of the information was greater for the treatment. This applies, both in the UK and US forces, to the precision of positional information. The underpinning of FBCB2/BFT by GPS provided extremely accurate positioning that met almost all user needs.
- In terms of the information sources exploited to inform individual sensemaking, the baseline scores significantly greater than the treatment. Principally, this is due to culture that exists, particularly, in the UK forces where commanders and staff derive information from multiple sources: face-to-face contact, orders, combat net radio and perceiving a situation first-hand. Consequently, FBCB2/BFT enhances other means of providing situational awareness and is not a means of replacing those methods.
- The baseline scored higher than the treatment for confidence. This may be explained by the propensity of both UK and US forces to rely on their respective radio networks that routinely support the exercise of command and control. It was noted, though, that "baseline" processes are prone to human error, particularly when personnel are exposed to stress such as fatigue or fear.

There was very close correlation between the responses from UK and US interviewees regarding the attributes for individual and shared sensemaking, hence, aggregated statistics are shown. The kiveat diagram in Figure 6.4-1 summarizes statistics for individual sensemaking.

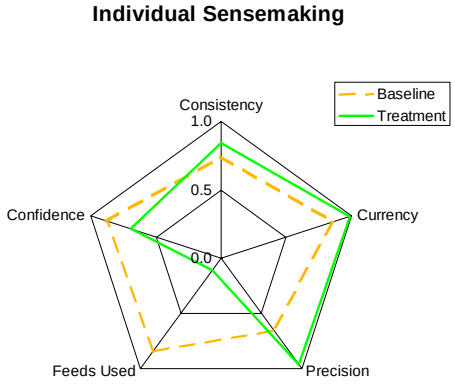


Figure 6.4-1, Aggregated Individual Sensemaking Statistics (based upon 29 interviews)

6.5 SHARED SENSEMAKING

Sensemaking is also a shared process. Individuals may perceive a different situation dependent on what their functional position demands. Shared awareness or sensemaking is essential for collaboration to ensure that the context for collective activity is harmonized.

There were several instances of FBCB2/BFT generating shared awareness or being exploited to provide shared awareness.

- Shared sensemaking was enhanced by virtue of those networked with FBCB2/BFT seeing exactly the same picture on their displays. This shared picture existed across unit, formation and national boundaries.
- 3d Battalion The Parachute Regiment (3 PARA) was equipped with one FBCB2/BFT system within the battlegroup headquarters. Even with this paucity of access to the system, the Patrols Platoon of the battlegroup used the system extensively. Access to maps, imagery and other digital geospatial data allowed the Platoon to plan in far greater detail and discern physical details that they had not been able to previously. Similarly, the system was used for collective debriefing whereby patrol members could contribute to debrief reports using the system as a back-drop.
- 3ID relied extensively on FBCB2/BFT for the distribution of orders, particularly, fragmentary orders in order to maintain shared sensemaking or situational awareness. Furthermore, the ability to share graphical data provided a capability to distribute information in a format that was contributed to collective sensemaking.

In the analysis of the treatment, the access to FBCB2/BFT, relative to the baseline, previous operations and exercises, the measures were, quite understandably, remarkably similar to those of the quality of individual sensemaking. The only discernable difference was in consistency where the differential between the treatment and the baseline was greater in favor of the treatment. This is may be explained by the fact that the reach of this network is wider, though not deeper, than existing radio networks. Consequently, FBCB2/BFT provides situational awareness beyond unit and formation boundaries, information that had not been readily available in the past. Hence, FBCB2/BFT offers a consistent picture where, before, intelligent guess-work has sufficed.

The statistics have been summarized in the kiveat diagram in Figure 6.5-1.

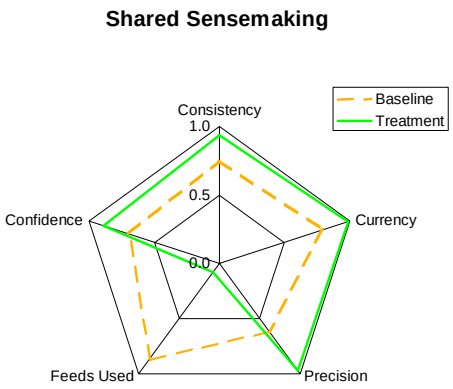


Figure 6.5-1, Aggregated Shared Sensemaking Statistics (based upon 29 interviews)

6.6 QUALITY OF INTERACTIONS

Interactions involve actors actively sharing information, developing awareness and understanding and making appropriate decisions in collaboration fashion within the context of command intent. The quality of interactions may be described with the aid of four top-level attributes: depth, breadth, intensity and agility.[24] The research was constrained to focus on some of the measures across the range of attributes, notably: quantity, quality, reach, latency, robustness and utility.

By virtue of FBCB2/BFT providing another network to augment what formations and units were accustomed to experiencing, the quantity of information available to all those equipped with FBCB2/BFT, the treatment, was greater than the baseline. As such, FBCB2/BFT becomes an enabler for interaction, either specifically or implicitly. Action may be taken on the receipt of information from another actor or action may be taken by seeing and interpreting what the actor is doing. The motivation to exploit the information differed between the UK and the US. Given the scarce number of systems, relative lack of training and the very late deployment of the system, UK forces relied on tried and tested means of interaction, specifically personal interaction and voice communications through combat net radio. Therefore, these methods of interaction remained their focus and they interacted little through FBCB2/BFT. This fact is highlighted in Figure 6.6.1-2. The US, however, relied more on FBCB2/BFT. The relatively earlier introduction of the system and the ability to train more individually and collectively meant that there was greater acceptance of the system. Additionally, as stated in Section 6, there was a need to seek alternate means of interaction when operating beyond line of sight. Given the circumstances outlined above and the balance of interviews between the UK and the US, the baseline scores significantly better than the treatment as shown in Figure 6.6.1-1.

The quality of the information provided by FBCB2/BFT to contribute to individual and collective awareness was very good, though there was only a very limited amount of information provided to the UK forces because they did not use the data dissemination capability. However, UK forces did use FBCB2/BFT frequently to check positional information passed over the radio networks. Hence, the quality measure for FBCB2/BFT is below that of the baseline, combat net radio, which was a richer source of information to the UK. The US preferred to exploit the capabilities of FBCB2/BFT to pass planning material and orders to facilitate interaction. Therefore, the treatment scores higher than the baseline.

Regarding the reach of the network to facilitate interaction, the UK network, with 47 nodes, was considerably smaller than that of the US, and its deployment is thought to be well below a “critical mass” where it could prove to have any substantial utility. As most systems were not deployed to company level and the system was not used for data transmission, the reach of the UK network was very limited and, naturally, scores well below the baseline as shown in Figure 6.6.1-2. In contrast, though the US network was not extensive, the 150 nodes allowed a distributed network down to company level maneuver units. The treatment scores lower than the baseline though as interactions are still conducted personally and on other nets.

The latency of the treatment and baselines are broadly similar. Routinely, FBCB2/BFT would update positional information, therefore, therefore minimizing time lags in the passage of this data. Interviewees were keen to point out that critical information such as a contact or

24 Evidence Based Research Incorporated, “Network Centric Operation Conceptual Framework”, Version 1.0, dated November 2003.

casualty reports could be sent almost instantaneously in the field, though routine reporting could be slower. The extremes of the radio reporting when averaged are similar to the minor time lag associated with FBCB2/BFT.

The comments on the robustness of both the FBCB2/BFT and radio networks were broadly similar and the statistics coincide, proving the relative robustness of both networks.

The final attribute that was measured was that of utility. As the study progressed, It was considered that "utility" better-described the usefulness of the network and aggregated a number of attributes together, such as flexibility and adaptability. The UK forces treatment was considerably lower than the baseline. There are 2 major contributors to this fact:

One formation, 3d Commando Brigade (3 Cdo Bde), deployed two TacSat channels that provided secure speech down to company level. As a consequence, this provided the Brigade the means of maintaining situational awareness in the tried and tested manner by engaging over the radio. Consequently, FBCB2/BFT was redundant in 3 Cdo Bde and provided only a link to assist in others' situational awareness.

The number of systems was not sufficient to alter operating procedures and one system per major unit provided little opportunity to exploit the capability of the system to any degree. There was always a requirement to maintain situational awareness using radios, maps and face-to-face briefings.

The US found more utility with the system, largely because it was deployed in greater numbers, there was direction to use it, there were circumstances where FBCB2/BFT was the only means of communication and they had time to train with it and develop confidence in the system. It was still not deployed widely enough to match the statistic of the baseline and it is not construed as a replacement for face-to-face interaction and verbal communication by radio.

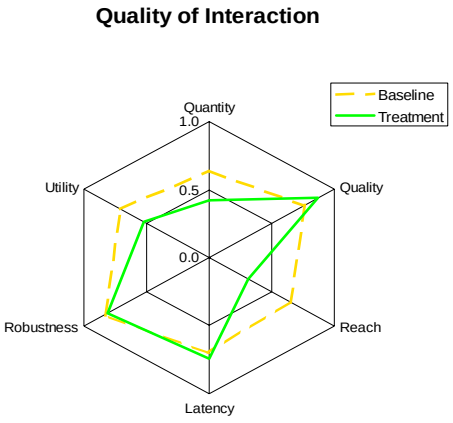


Figure 6.6.1-1, Quality of Interactions in US Forces (8 interviews)

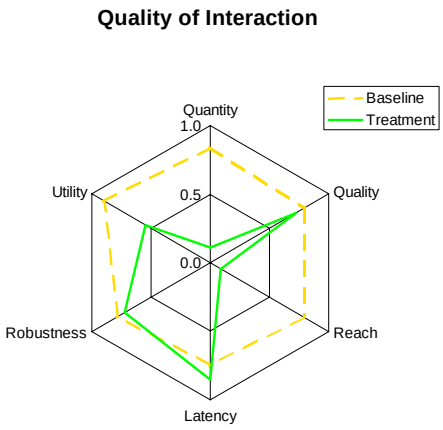


Figure 6.6.1-2, Quality of Interactions in UK Forces (21 interviews)

6.7 DEGREE OF EFFECTIVENESS

It would be difficult with such a small sample size to generate robust statistics on the effectiveness of the deployment of FBCB2/BFT. However, this project has engaged with subject matter experts in order to evaluate the following hypothesis:

"During Operation TELIC/Iraqi Freedom, the direct accessibility to FBCB2/BFT by UK and US units provided:

- *Improved individual sense-making*
- *Enhanced the quality of interactions*
- *Improved shared sense-making*
- *Increased mission effectiveness*

… relative to previous operations and training without FBCB2/BFT".

It is believed that there is sufficient evidence provided in the research to provide trends and indicators for enhanced mission effectiveness. The research has identified a major difference in how UK and US forces operated and exploited the system. The system proved to be far more effective within the US forces and the reasons for this have been explained in this report. However, the potential of such a system is recognized by the UK. Therefore, the following points demonstrate how effective the system was, particularly in 3ID, and how it could be exploited in the future:

6.7.1 Tempo

The unprecedented speed of maneuver and tempo that was generated and maintained by US forces would not have been possible without FBCB2/BFT. FBCB2/BFT enabled 3ID to exercise command and control on the move that facilitated execution of rapid advances and bold maneuvers for a geographically dispersed force. There are, principally, two factors to support this:

- Command and control would have been extremely difficult without an alternate means of communication. The FM radio network that underpins tactical command and control was challenged as US forces sought to rapidly build on early successes and exploit the elements of speed and surprise. FBCB2/BFT allowed communication beyond line of sight and also provided a means to be able to pass orders and tactical overlays. This helped sustain the required momentum.
- High individual and shared awareness allowed commanders at all levels to appreciate the wider operational context. Commanders had the option of synchronizing their operations directly by physical contact with flanking units or loosely synchronizing, or conforming, to other units through FBCB2/BFT-enabled situational awareness. This flexibility allowed them to exploit opportunity when it was presented.

6.7.2 Agility

FBCB2/BFT did not necessarily provide agility to the force given its relatively low density of deployment; however, it did contribute significantly to command and control agility. FBCB2/BFT provided two key elements of situational awareness: the disposition of blue forces in time and space and a picture of the operational environment. Command intent was also disseminated through the chain of command. Only the enemy picture was not provided. As such, units had an infinitely better level of situational awareness than had been experienced previously.

FBCB2/BFT provided commanders information quicker on the disposition of blue forces. There is evidence to indicate that commanders could make decisions quicker and direct their units faster to enable more rapid maneuver. Having access to information quicker, commanders were also able to delay decision-making, providing them with a greater degree of operational freedom.

Commanders were also able to shift their attention from planning to current operations more rapidly by perceiving the battlespace graphically through FBCB2/BFT in a form that allowed them to assimilate the situation at a glance.

6.7.3 Synchronization

The ability to network a force with FBCB2/BFT does allow the force the potential for a greater degree of synchronization without the need for greater coordination by radio. The ability to see blue icons maneuvering on a display, viewed at a number of scales, does allow the user the ability to better make sense of the operational context. Factors such as command intent, training and doctrine will allow the user to draw inferences from the movement to create understanding in order to be able to orientate and act.

This was demonstrated when 1 BCT delayed its attack on an objective because 2 BCT had been delayed by up to 18 hours. 1 BCT was able to amend its course of action early with the knowledge gleaned from FBCB2/BFT that otherwise may not have been available. At the lower tactical level, the ability of a company commander to synchronize his activities with other movement in the battlespace without recourse to voice communications proves the utility of the system.

7. LIST OF PEER REVIEWERS

7.1 PEER REVIEWERS – GENERAL

While a list of peer reviewers was identified at the beginning of this case study, given organizational changes and their general availability, the actual list of individuals who were able to formally participate in reviews varied over the course of the case study.

Since the initial focus of our study was on UK forces, peer reviewers out of CBM J6 were identified. We felt that the NCO CF workshop itself provided a consistent opportunity to get input from a number of US based resources out of DoD, including DoD OFT and OASD NII, academia, and other case study participants.

Those peer reviewers who were identified within UK MOD CBM J6 included:

- Brigadier Nigel Jackson
- Lt Col Phil Joyce
- Sqn Ldr Phil Mitchell

CBM J6 was provided an advance copy of the report and fully supports the analysis and findings[25].

We also worked with the Office of Force Transformation to provide the opportunity for PM FBCB2 to review and comment on our preliminary findings. Reviewers from PM FBCB2 included:

- Lt Col John Bullington
- Maj Phil Bird (UK liaison to PM FBCB2)

Peer reviewers were also invited to participate in the various NCO CF workshops held by EBR. During these workshops, PA held individual working sessions with the reviewers in order to capture their input to the case study at its various stages of development.

7.2 WORKSHOP #4 PEER REVIEW

As a final step at the NCO CF Workshop #4, an EBR-commissioned peer review comprised of workshop participants was conducted for each of the primary case study Draft Final Report Briefs. Given the thoroughness of that review and the relevance of the comments to our Final Report, we have included the peer review groups comments and recommendations in this document along with our response. The peer review consisted of the following individuals (including members of the PA case study team):

- Maj Philip Bird, MOD UK, liaison to US PM FBCB2
- COL Craig Burris, J-6A

25 Office call conducted by Ian McDougall with Lt Col Phil Joyce and Sqn Ldr Phil Mitchell, 26 May 2004.

7. List of peer reviewers

- Maj Gen (ret) Dean Cash, Raytheon
- Joanna Centola, Evidence Based Research
- Dan Gonzales, RAND
- Mike Johnson, RAND
- Dr. Jimmie McEver, Evidence Based Research
- Squadron Leader Philip Mitchell, MOD, UK
- COL (ret) Jay Tisserand, MPRI/ U.S. Army War College
- COL (ret) Duane Williams, MPRI/ U.S. Army War College

The peer review team was asked to evaluate the case study in terms of required content of the Final Report along with an overall assessment of how well that requirement was met and any corresponding recommendation to improve upon that requirement if necessary

The results of that assessment and the specific actions taken or comments by PA are covered in Appendix F. Peer reviewers comments are organized into the categories provided at the workshop (Operational Context, Scope and Assumptions, etc). Specific comments within each category are further *numbered* and are followed by the PA response.

8. CONCLUSIONS AND RECOMMENDATIONS

The high-level conclusions and recommendations resulting from this case study are summarized below in sections relating to the case study hypothesis, more generalized issues relating to the deployment of NCO transformation, and an evaluation of the use of the NCO CF for analyzing case studies such as this.

8.1 CASE STUDY HYPOTHESIS

In general, most of the interviews conducted as part of this case study did support the hypothesis that deployment of FBCB2/BFT enhanced operational effectiveness. Specific areas where improved operational effectiveness was identified as a direct result of the deployment of FBCB2/BFT included:

- Planning – specifically the access to multi-scale mapping and imagery and the distribution of schematics that enabled better task planning, mobility assessment, weapons siting and communications;
- Command and Control Agility – the enhanced speed with which they could assimilate a picture of the battlefield environment enabled commanders to respond more quickly to changing situations and exert command and control where most appropriate;
- Tempo – the capability for quicker decision-making had the potential to generate tempo, as did the ability to de-conflict maneuvers in near real time;
- Enhanced command and control – the BLOS communications in the treatment enabled 3ID to operate effectively in a far more dispersed fashion than was normally the case and to undertake command and control while on the move;
- Synchronization – there were a number of examples where the improved visibility of the battlefield environment enabled commanders to adopt better courses of action within the collective scheme of maneuver.

In some cases the magnitude of improvement was relatively low compared with the potential of the system. The deployment issues that influenced some of this shortfall are discussed in the following section.

Because of the limited scope of this case study (primarily FBCB2/BFT usage at the tactical level) a more comprehensive study of benefits of this in the context of other related SA technology such as C2PC and at operational and strategic levels of command within OIF would be beneficial.

8.2 DEPLOYING NCO TRANSFORMATION

The majority of the UK interviewees concluded that FBCB2/BFT had failed to deliver its full potential during operations in Iraq. Conversely, US forces, specifically those in 3ID, believed that FBCB2/BFT provided a considerable enhancement to operational effectiveness. However, a significant proportion of the shortfall against the system's potential was associated with it having been fielded in a hurried manner – without the normal maturity across all the lines of development. Furthermore, for more complex NCO transformations it is

clear that the integration of all these lines of development will become increasingly important. Some specific lessons that can be generalized from this case study to the deployment of any complex NCO transformation include:

- It is strongly recommended that any future deployment of new technology such as FBCB2/BFT be accompanied by adequate individual and collective training, and time in which to develop new TTPs in order to ensure enhanced mission effectiveness during combat operations;
- For systems intended to provide Combat ID / blue picture it is essential that they are deployed in sufficient density ("critical mass") to build a meaningful and accurate picture. In the case of FBCB2/BFT, the blue picture would have been adequate for use at operational and strategic levels of command, but was too sparse for any significant contribution to situational awareness at lower tactical levels;
- Leadership involvement in training and subsequent direction in usage of systems such as FBCB2/BFT appears to make a significant difference in the utilization of the technology;
- Where units are highly mobile and operating over significant distances, communications will need to be supported by suitable BLOS systems such as TacSat or other SatComms;
- Per interviews with the 3ID, it was commonly recommended that combat support and combat service support units be provided with the same SA as maneuver units in order to leverage improved collective performance;

8.3 EVALUATION OF THE NCO CONCEPTUAL FRAMEWORK

The following section highlights issues and perceived weaknesses along with proposed actions related to the NCO CF. At the highest levels, we recommend that:

- The language of the NCO CF be changed so it is better understood by combat units and non-US forces
- Quantifying metrics related to combat operations – as was done for this case study – can be very difficult. Beyond this report, it is recommended that a focused effort be made to incorporate into the NCO CF recommendations for improvement and lessons learned from the application of NCO CF within the various case studies. It is recommended that further analysis be undertaken to relate operational lessons learned to the context of the NCO CF.
- The influence of exogenous variables such as DOTMLPF can be as significant as those in the NCO CF. Further analysis should be done in this area, particularly Doctrine and Training - the framework and approach to its application should be updated accordingly.
- The utility of formally incorporating elements of the NCO CF into any After Action Review process should be explored

More detailed recommendations are included in Appendix G.

APPENDIX A: GLOSSARY

1 (UK) Armd Div	1st (United Kingdom) Armored Division
1 BCT	1st Brigade Combat Team
1 MEF	1st Marine Expeditionary Force
1 PARA	1st Battalion The Parachute Regiment
1 R IRISH	1st Royal Irish Regiment
1 RRF	1st Battalion Royal Regiment of Fusiliers
15 MEU	15th Marine Expeditionary Unit
16 AA Bde	16th Air Assault Brigade
2 RTR	2nd Royal Tank Regiment
3 Cdo Bde	3 Commando Brigade
3 PARA	3rd Battalion The Parachute Regiment
3/7 Cav	3/7 Cavalry Squadron
3ID (1 BCT)	3rd Infantry Division (1st Brigade Combat Team)
3ID	3rd Infantry Division
40 Cdo	40 Commando Royal Marines
42 Cdo	42 Commando Royal Marines
51 Sqn RAF Regt	51 Squadron Royal Air Force Regiment
7 Armd Bde	7th Armored Brigade
AAR	After Action Review
ACC	Air Component Commander
AFATDS	Advanced Field Artillery Tactical Data System
ASAS (Lt)	All Source Analysis System (Light)
ATacCS	Army Tactical Command System
BATUS	British Army Training Unit Suffield

BFT	Blue Force Tracking
BLOS	Beyond Line-of-Sight
BOS	Battlefield Operation System
C2PC	Command and Control Personal Computer
CENTCOM	US Central Command
CFLCC	Combined Force Land Component Commander
CLANSMAN CNR	Clansman Combat Net Radio
DoD	US Department of Defense
DOTMLPF	Doctrine, Organization, Training, Materiel, Leadership, Personnel, Facilities
EPLRS	Enhanced Position Location Reporting System
FBCB2	Force XXI Command Brigade and Below
FBCB2 PM	FBCB2 Program Manager
FRAGOs	Fragmentary Orders
G3	G3 (Operations) Staff Branch
GCCS	Global Command and Control System
HF	High Frequency
HQ	Headquarters
HQ USMC C4/CIS	Headquarters United States Marine Corps Command Control, Coordination and Computing/Command Information Systems
IAEA	International Atomic Energy Authority
JFLogC	Joint Force Logistic Component
JOCS	Joint Operational Command System
JOP	Joint Operational Picture
LCC	Land Component Commander

LD	Line of Departure
MCC	Maritime Component Commander
MoFE	Measure of Force Effectiveness
MoD	UK Ministry of Defence
MoMS	See page 91
NBC	Nuclear, Biological and Chemical
NCO	Network Centric Operations
NCO CF	Network Centric Operations Conceptual Framework
NCW	Network Centric Warfare
NEC	Network Enabled Capabilities
OASD	Office of the Assistant Secretary of Defense
OC Patrols Platoon	Officer Commanding Patrols Platoon
OIF	Operation IRAQI FREEDOM
OP TELIC	Operation TELIC
OSD OFT or OFT	Office for the Secretary of Defense, Office of Force Transformation
PA	PA Consulting Group
PJHQ	Permanent Joint Headquarters
PLGR	Personal Lightweight GPS Receiver
Rt Hon	Right Honourable (Status assigned to senior UK Members of Parliament – members of the Privy Council)
SA	Situational Awareness
SAIF SEREEA	Delete – exercise name
SCOTS DG	Scots Dragoon Guards (British Armored Regiment)
SINCGARS	Single Channel Ground and Airborne Radio System

SIPRNET	US Classified Intelligence and Messaging Network
TacSat	Tactical Satellite
TTPs	Tactics, Techniques and Procedures
UK NCC	United Kingdom National Contingent Commander
UNMOVIC	United Nations Monitoring and Verification and Inspection Commission
UNSCOM	United Nations Special Commission
UNSCR	United Nations Security Council Resolution
V-Corps	5th (US) Corps
WME	Weapons of Mass Effect

APPENDIX B: AFTER ACTION REPORTS

The following After Action Reports (AARs) were utilized to inform the research:

1. *Operations in Iraq - First Reflections*, Ministry of Defence, London, July 2003
2. *Field Report*, US Marine Corps System Command Liaison Team, April 2003
3. *The Iraq War: A Working Chronology*, CSIS, Washington, April 2003
4. *The "Instant Lessons" of the Iraq War*, CSIS, Washington, May 2003
5. *Operation IRAQI FREEDOM - After Action Report, Third Infantry Division, May 2003*
6. *Operation IRAQI FREEDOM – US/UK Operations, Jim Dutton and Tom Waldhauser, RUSI Journal, December 2003*
7. *Brief On 1 Mardiv – Observations, April 2003*
8. *Digital Battle Command – Baptism by Fire*, Lt Col Charlton, 1-15 Infantry, 3 ID

APPENDIX C: LIST OF INTERVIEWS CONDUCTED WITH OIF PARTICIPANTS

C.1 INSTRUMENTAL INTERVIEWS

Interviewee	Position During OIF	Unit During OIF
Capt Mark Hewett	SO2 G3 O&D	1 (UK) Div
Maj Justin Maciejewski	SO2 G3 Ops / O&D	1 (UK) Div
Maj Dick Scott	SO2 G3 Trg/EPS	1 (UK) Div
Capt Mally Davies	SO3 G3 Trg Res	1 (UK) Div
Capt Andy Cox	SO3 G3 Ops	7 Armd Bde
Maj Duncan McSporran	Z Coy Cmdr	1 RRF
Capt Joe Butterfield	BG Ops	1 RRF
Maj John Collicutt	BG 2I/C	1 RRF
Maj Richard Woodward	Sqdr leader	2 RTR
Capt James Porter	2 I/C Falcon Sqdr	2 RTR
Capt Colin Dobeson	C Sqn Battle Capt	Scots DG
Maj Dave Clark	SO2 G3 Trg	HQ 3 Cdo Bde
Maj Haydon White	SO2 Ops	HQ 3 Cdo Bde
Maj Alex Janzen	SO3 G6 CIS	HQ 3 Cdo Bde
Capt Richard Mears	Sigs Offr	42 Cdo
Capt Nick Sargent	Ops Offr	29 (Cdo) Regt RA
Maj Phil Oxley	Adjt	29 (Cdo) Regt RA
Maj Richard Hendrickse	SO3 Arty Ops	HQ 1 (UK) Arrmd Div
Sgt Garteh Collins	SNCO AD Cell	16 Air Asslt Bde
Maj Fred Gray	Adjt	1 PARA
Capt Andy Redding	Asst Ops Offr	3 PARA
Maj Garth Horne	S3	11 Engr Bn
Capt Jerry Robbins	Coy Comd	3/69 Armr
Col Will Grimsley	Comd	1 Bde
Lt Col Pete Bayer	G3	3ID
Lt Col Terry Ferrell	CO	3/7 Cav
Lt Col Mike Johnson	XO	3/69 Armr
Lt Col Rock Marcone	CO	3/69 Armr
Maj Mike Oliver	S3	3/69 Armr

C.2 INFORMATIONAL INTERVIEWS OF OIF PARTICIPANTS

Interviewee	Post during OIF	Unit during OIF
MAJ Geoff Thome	Information Management Officer	1MEF
COL John Coleman	G3	1MEF
COL Chris Conlin	Commander	1st Battalion, 7th Marines (Battalion Combat Team)
COL Larry Brown	G2	1MEF
CMDR Bruce Szymanski	C4I Systems Integration Chief, J3	CENTCOM
BGen Tom D. Waldhauser	Former commander 15MEU during OIF	15MEU, 1MEF
CPT James Conatser	US Army FBCB2 OIF deployment team	FBCB2 PM
LT COL Mike Sweeney	C4/CS	HQ USMC C4/CS
MAJ Phil Bird	Liaison officer to US FBCB2 PM, OIF deployment team	British Army, UK MOD,
LT COL John Bullington	FBCB2 PM	
	FBCB2 Program Office Deputy PM and staff	
LTC Wayne Parks		CFLCC
COL Tom Kruegler		V Corps
LTC Todd Wood		3ID 1BCT (Division Main)
CPT Mike Kelly		3ID, 1BCT, 2-7 Infantry
Brig J Dutton	Commander	UK 3 Cdo Bde
Wg Comd Q Dixon		RAF
Maj D Chalmers		1 R IRISH
Neil Verrall		DSTL

APPENDIX D: INTERVIEW TEMPLATE

BACKGROUND INFORMATION

This interview is to support US Department of Defense research into network enabled capabilities. PA Consulting Group has undertaken one work-stream assessing the impact of technology on individual and shared awareness and decision-making during high intensity operations – Operation TELIC. We aspire to be able to quantify any improvement in combat effectiveness associated with the technology.

These interviews are exceedingly important to our research. You are a subject matter expert (SME) and your response will be aggregated with a number of others to identify trends and patterns and, potentially, derive some objective measures. Our findings will be fused with the findings from five other research projects. This will advance knowledge on NEC and contribute to future systems development.

The interview is divided into 4 sections and I will brief you at the start of each on the objectives for the particular section. Please feel free to ask questions at these times.

Please minimize the use of military acronyms for my benefit! I would like you to be as candid as possible, the aim is to identify strengths and weaknesses in exploiting new technology. Do you have any questions before we start?

Initially, I would like to ask you some background questions to set the scene and focus your thoughts on the Operation and the use of technology, particularly FBCB2/BFT.

1. Please provide an overview of your appointment, role and unit during Op TELIC.

2. Please describe the formation the unit you were part of and the other units within the formation during each phase of the operation.

3. Please provide an overview of the wider coalition organizational structure and your formation/unit interaction with this wider community.

(1MEF, 1 (UK) Armd Div, UK Bdes, 15 MEU)

4. Please provide an high level overview of the operations/missions conducted by your formation/unit over time.

5. Please provide a description of the communications and information systems employed within your formation/unit prior to deploying to the Middle East and its connectivity upwards, downwards and sideways.

(JOCS, PTARMIGAN trunk communications, Combat Net Radio (CNR), Personal-Role Radio (PRR), FBCB2/BFT, C2PC, SIPRNET, CENTRICS-X, X-Net etc)

6. Please provide a description of the communications and information systems employed within your formation/unit following deployment to the Middle East and its connectivity upwards, downwards and sideways.

(JOCS, PTARMIGAN trunk communications, Combat Net Radio (CNR), Personal-Role Radio (PRR), FBCB2/BFT, C2PC, SIPRNET, CENTRICS-X, X-Net etc)

7. How was FBCB2/BFT deployed within your formation/unit?
(Battlegroup tactical HQ (CO's vehicle), battlegroup main HQ, company commander's vehicle, company command post?)

8. Who decided and directed the deployment?

9. What was the rationale for this deployment?

10. Were you aware of the capabilities of the system? If so, can you describe them?

(Spatial awareness, multiple scale mapping, imagery, elevation data, navigation, data transmission, free text messaging, line-of-sight tool, overlay creation etc)

11. Which capabilities of FBCB2/BFT did you exploit?

12. Who trained on FBCB2/BFT?

13. Were commanders aware of the capabilities of the system?

14. Did you have any direct interaction with members/units of coalition forces? If so, can you describe the nature of these interactions and how any of the above discussed technologies, if any, contributed to these interactions?

15. Did your unit have Air and Naval Gun Liaison Company (ANGLiCO)? Can you describe your interactions with this unit.

OPERATIONS WITH FBCB2/BFT

I am going to ask you some questions now that are directly related to the operation of FBCB2/BFT. Please consider whether there was some impact from FBCB2/BFT either directly or indirectly i.e. you had the system and provided information from that system to others such that they had indirect access to information from the system. Do you have any questions?

1. Briefly describe the information passed over FBCB2/BFT.

2. Did you have a plan for the way you would operate FBCB2/BFT?

3. Did you conform to the plan or did it change as operations were conducted?

4. What was the availability of FBCB2/BFT?
(TACSAT infers that coverage and availability was better than CNR. Was it always switched on?)

5. Did FBCB2/BFT provide you with greater awareness of the battlespace?
(SA is fusion of command intent, friendly and enemy forces and environment. BFT provides a proportion of this SA)

6. How current was your situational awareness?

7. How current was collective situational awareness?

8. Did FBCB2/BFT add value to your situational awareness? Are you able to quantify this?

9. Did FBCB2/BFT, in your opinion, add to others' situational awareness? Are you able to quantify this?

10. Did FBCB2/BFT allow you to interact and synchronize better with other units operating FBCB2/BFT?

11. How did BFT and non-BFT units interact? Did BFT contribute, at all, to a capability gap between the "haves" and "have nots"?

12. Did FBCB2/BFT affect the volume of traffic over CNR?
(Potentially reduce the requirement for location reporting for those equipped units?)

13. If so, did the volume of traffic on CNR change from the time UK forces entered Iraq until the time when Basrah was secured?

14. Did commanders exploit the capabilities of FBCB2/BFT? To what extent?

15. Where, within your chain of command, do you envisage the deployment of FBCB2/BFT providing greatest benefit? Why?

16. What red picture were you provided through FBCB2/BFT?

17. How confident were you in the information provided on blue forces through FBCB2/BFT?

18. How confident were you in the information provided on red forces through FBCB2/BFT?

19. Did FBCB2/BFT contribute to your decision-making?

20. Did FBCB2/BFT contribute to others' decision-making?

21. Did the system allow you to undertake tasks more efficiently? If so, in what way?
("Could you do things better?")
(Planning times quicker, provide more time for battle preparation, better able to self-synchronize actions, conformity to wider scheme of maneuver?)

22. Did the system allow you to undertake new activities that you had not practiced in the past?

("Could you do better things?")

23. Did your formation/unit develop revised tactics, techniques and procedures as a result of having FBCB2/BFT?
(Was there iterative development of TTPs through experience?)

24. Can you remember any particular vignettes, related to operations in Iraq, using FBCB2/BFT? Could you explain them to me and relate them to how they impacted upon your effectiveness?

OPERATIONS WITHOUT FBCB2/BFT

This section will deal with the way you operate without FBCB2/BFT i.e. prior to Op TELIC. I would like you to respond to the questions highlighting the way you operated while engaged on combined or field training exercises such as Ex SAIF SEREEA, training in BATUS or in Poland. Do you have any questions?

1. *How did you perceive your situational awareness?*

2. *What was the extent of this situational awareness? How many others shared the same "picture"?*

3. *How appropriate for use was your situational awareness?*

4. *How appropriate for use did you believe the collective situational awareness to be?*

5. *How current was your situational awareness?*

6. *How current was collective situational awareness?*

7. *How did you synchronize your actions and activities with others?*

8. *How effective do you assess this level of synchronization to be?*

9. *Can you remember any particular vignettes related to the methods of obtaining situational awareness during previous combined arms or field training exercises? Can you relate these vignettes to how effective you were?*

OBJECTIVE MEASURES

These questions are designed to consider some objective measures in order that we may identify some trends associated with the deployment of FBCB2/BFT. In most cases we are attempting to identify measures in effectiveness between the operational deployment of the system and the ways you operated prior to the Operation i.e. training in BATUS or Poland. You will be shown a number of scales to quantify a particular attribute; please take your time to give the question due consideration and assess the response scales. Do you have any questions?

1. Information Currency. ***(IA)***

   a. How current did you need information to be in your role?

   (Quantification of fixed time period)

   b. What was the time lag between events occurring and you, equipped with FBCB2/BFT, becoming aware of the event? e.g. blue and red force movements and the distribution of tactical information.

   (Time period)

   c. Can you quantify the time lag between events occurring and staff knowing of such events when you operated on previous combined arms and field training exercises?

   (Time period)

2. Information Currency. ***(SA)***

   a. How current did your unit and others need information to be?

   (Time period)

   b. Can you assess the time lag associated between an event occurring and the FBCB2/BFT-equipped units becoming aware of the event? e.g. blue and red force movements and the distribution of tactical information.

(Time period)

c. Can you assess the time lag in understanding when your unit and others operated on previous combined arms and field training exercises?

(Time period)

3. Information Precision. ***(IA)***

a. What level map scales do you require in your role? *(e.g. 1:50K)*

b. What map scale did you utilize when operating FBCB2/BFT?

c. What level of resolution do you require for objects in your role? e.g. blue and red forces and other tactical information. *(Answer in meters)*

d. What level of resolution did FBCB2/BFT provide you for objects?

e. Can you quantify the map scales that you utilized on previous combined arms and field training exercises? *(e.g. 1:50K)*

f. Can you quantify the resolution of objects you used on previous combined arms and field training exercises? *(Answer in meters)*

4. Information Precision. ***(SA)***

a. What level of information (map scales and objects) do you believe is required to maintain collective situational awareness? *(Scale and meters)*

b. Can you quantify the level of granularity FBCB2/BFT provided to your unit and others through FBCB2/BFT? *(Scale and meters)*

c. Can you quantify the level of granularity that your unit and others may have experienced on previous combined arms and field training exercises? *(Scale and meters)*

5. Information Uncertainty. ***(IA)***

a. Can you assess the confidence level you had in the information you perceived from FBCB2/BFT?

Low	Medium	High

b. Can you assess the confidence you had in the information you perceived from CNR on previous combined arms and field training exercises?

Low	Medium	High

c. What level of confidence do you require to be able to make decisions?

Low	Medium	High

(Low – High, this is a complex question but should elicit a response on issues of confidence, trust, acceptance of technology etc.)

6. Information Uncertainty. ***(SA)***

a. Can you assess the level of confidence in the passage of information throughout the FBCB2/BFT community?

Low	Medium	High

b. Can you assess the level of confidence in the passage of information through your Company/Squadron Group and Battlegroup in previous exercises?

Low	Medium	High

c. What level of confidence do commanders and staff require to make decisions?

Low	Medium	High

7. Information Relevance. ***(IA)***

a. Can you quantify the proportion of your information needs met by FBCB2/BFT?

(Percentage)

b. Can you quantify the proportion of your information needs met by CNR?

(Percentage)

8. Information Relevance. ***(SA)***

a. Can you quantify the proportion of Commanders' information needs met by FBCB2/BFT?

(Percentage)

b. Can you quantify the proportion of Commanders' information needs met by CNR?
(Percentage)

9. Information Consistency. ***(IA)***

a. Can you assess the degree to which information through FBCB2/BFT was consistent with prior derived information?

1	2	3	4	5

Completely Inconsistent Completely Consistent

b. Can you assess the degree to which information through CNR was consistent with prior derived information?

1	2	3	4	5

Completely Inconsistent Completely Consistent

10. Information Consistency. ***(SA)***

a. Can you assess the extent to which shared information through FBCB2/BFT is consistent across the force?

1	2	3	4	5

Completely Inconsistent Completely Consistent

b. Can you assess the extent to which shared information through CNR is consistent across the force?

1	2	3	4	5

Completely Inconsistent Completely Consistent

Information Reach. ***(QoI)***

a. Can you quantify the number of personnel in your unit utilizing FBCB2/BFT to gain situational awareness? *(This will exceed the number of systems deployed as one system may serve several staff)*

(Ratio/Percentage of unit strength)

b. Can you quantify the number of personnel in your unit utilizing CNR to gain situational awareness?

(Ratio/Percentage of unit strength)

11. Information Quality. ***(QoI)***

a. Can you assess the quality of information and awareness through interactions with FBCB2/BFT?

1	2	3	4	5

Very Poor *Excellent*

b. Can you assess the quality of information and awareness through interactions with CNR on previous on previous combined arms and field training exercises?

1	2	3	4	5

Very Poor *Excellent*

12. Information Latency. ***(QoI)***

a. Can you assess the time-lag associated with information availability through FBCB2/BFT?

1	2	3	4	5	6	7	8	9	10

Considerable/Significant Minor/Insignificant

b. Can you assess the time-lag associated with information availability through CNR?

1	2	3	4	5	6	7	8	9	10

Considerable/Significant *Minor/Insignificant*

13. Robustness. ***(QoI)***

a. Can you assess the availability of the FBCB2/BFT network to deliver information?

1	2	3	4	5

Never Available Constantly Available

b. Can you assess the availability of the CNR network to deliver information on previous combined arms and field training exercises?

1	2	3	4	5

Considerable/Significant *Minor/Insignificant*

(Statistics from the FBCB2/BFT PM will augment this response)

14. Utility. ***(QoI)***

a. Can you the assess level to which FBCB2/BFT provided the ability to identify *(different)* courses of action?

1	2	3	4	5

No Utility Considerable Utility

b. Can you assess how CNR provided the ability to identify *(different)* courses of action on previous combined arms and field training exercises?

1	2	3	4	5

No Utility Considerable Utility

15. Relative Effectiveness. Of all the new equipment and systems deployed on the operation, can you assess what percentage of improvement FBCB2/BFT directly contributed to?

16. Coalition Operations.

a. Did FBCB2/BFT engender a level of trust between the Coalition partners? Please explain your response.

b. Did FBCB2/BFT contribute to greater cooperation between Coalition partners? Please explain your response.

c. Did you have confidence in the FBCB2/BFT system and the method of operation across the Coalition? Please explain your response.

OVERALL COMMENTS

This final section is to gather your comments, generally, about FBCB2/BFT. It provides an opportunity to seek the overall strengths and weaknesses of the system and understand if there could be more potential in the system if it were to be deployed differently. Do you have any questions?

1. What was your overall impression about the utility of FBCB2/BFT?

2. Do you believe that the system offers some potential beyond the current capabilities within your current formation/unit?

3. If the system were to be deployed again:

    a. Would you alter the deployment?

    b. Would you exploit the system differently?

4. Have you any other comments on the system?

APPENDIX E: DATA ANALYSIS

This appendix describes the approach that has been taken to analyzing and presenting the data from the objective measures section of the instrumental interviews – see interview template in Appendix F. The answers to all of these questions were entered into an Excel spreadsheet and analyzed as outlined below.

E.3 DATA INPUT

The quantitative data from each interview was entered into the spreadsheet as a single column including metadata elements to enable future cross-reference that included:

- Interview reference number
- Name
- Rank
- Role
- Military unit
- Interview date

Each objective measures question was asked for the treatment case (i.e. in OIF with the use of FBCB2/BFT) and for the baseline (i.e. prior to OIF with combat net radio and whatever other sources of situational awareness were routinely available).

Each of the objective measures questions had an associated scale. In some case the question asked for a straightforward measure – such as a percentage, meters accuracy or minutes of latency. In these cases the data was entered into the spreadsheet directly using the units included within the question.

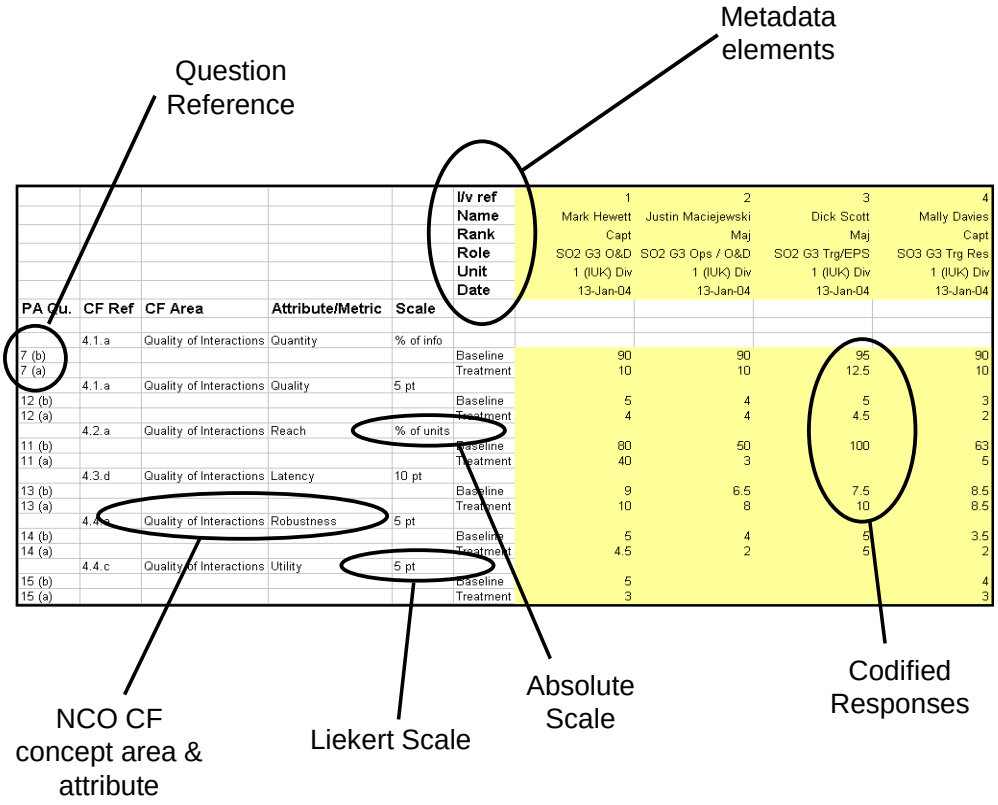
In other instances, a Liekert scale was utilized with an appropriate number of points – usually three or five point scales, as shown below. The answers to these questions were then codified – scoring one for the lowest point on the scale and working up in integers, according to the number of the points on the scale. If a respondent scored an answer between two categories this was scored as the average of the categories it fell between.

c. Can you assess the confidence level you had in the information you perceived from FBCB2/BFT?

Low	Medium	High

If a respondent felt unable to answer any particular question the appropriate spreadsheet cells would be left blank and the statistics for that particular question would show a reduced number of samples.

An example of the raw data entry section of the spreadsheet is shown below – with examples of the associated metadata and scales – including both absolute scales and Liekert scales.



					I/v ref	1	2	3	4
					Name	Mark Hewett	Justin Maciejewski	Dick Scott	Mally Davies
					Rank	Capt	Maj	Maj	Capt
					Role	SO2 G3 O&D	SO2 G3 Ops / O&D	SO2 G3 Trg/EPS	SO3 G3 Trg Res
					Unit	1 (IUK) Div	1 (IUK) Div	1 (IUK) Div	1 (IUK) Div
					Date	13-Jan-04	13-Jan-04	13-Jan-04	13-Jan-04
PA Qu.	**CF Ref**	**CF Area**	**Attribute/Metric**	**Scale**					
	4.1.a	Quality of Interactions	Quantity	% of info					
7 (b)					Baseline	90	90	95	90
7 (a)					Treatment	10	10	12.5	10
	4.1.a	Quality of Interactions	Quality	5 pt					
12 (b)					Baseline	5	4	5	3
12 (a)					Treatment	4	4	4.5	2
	4.2.a	Quality of Interactions	Reach	% of units					
11 (b)					Baseline	80	50	100	63
11 (a)					Treatment	40	3		5
	4.3.d	Quality of Interactions	Latency	10 pt					
13 (b)					Baseline	9	6.5	7.5	8.5
13 (a)					Treatment	10	8	10	8.5
	4.4.a	Quality of Interactions	Robustness	5 pt					
14 (b)					Baseline	5	4	5	3.5
14 (a)					Treatment	4.5	2	5	2
	4.4.c	Quality of Interactions	Utility	5 pt					
15 (b)					Baseline	5			4
15 (a)					Treatment	3			3

E.4 DATA ANALYSIS

The Excel spreadsheet included all of the data analysis necessary to normalize the results, calculate appropriate statistical measures and present the results in a number of graphical formats.

First a range of statistics was calculated from the baseline and treatment data sets for each quantitative question. These statistics included:

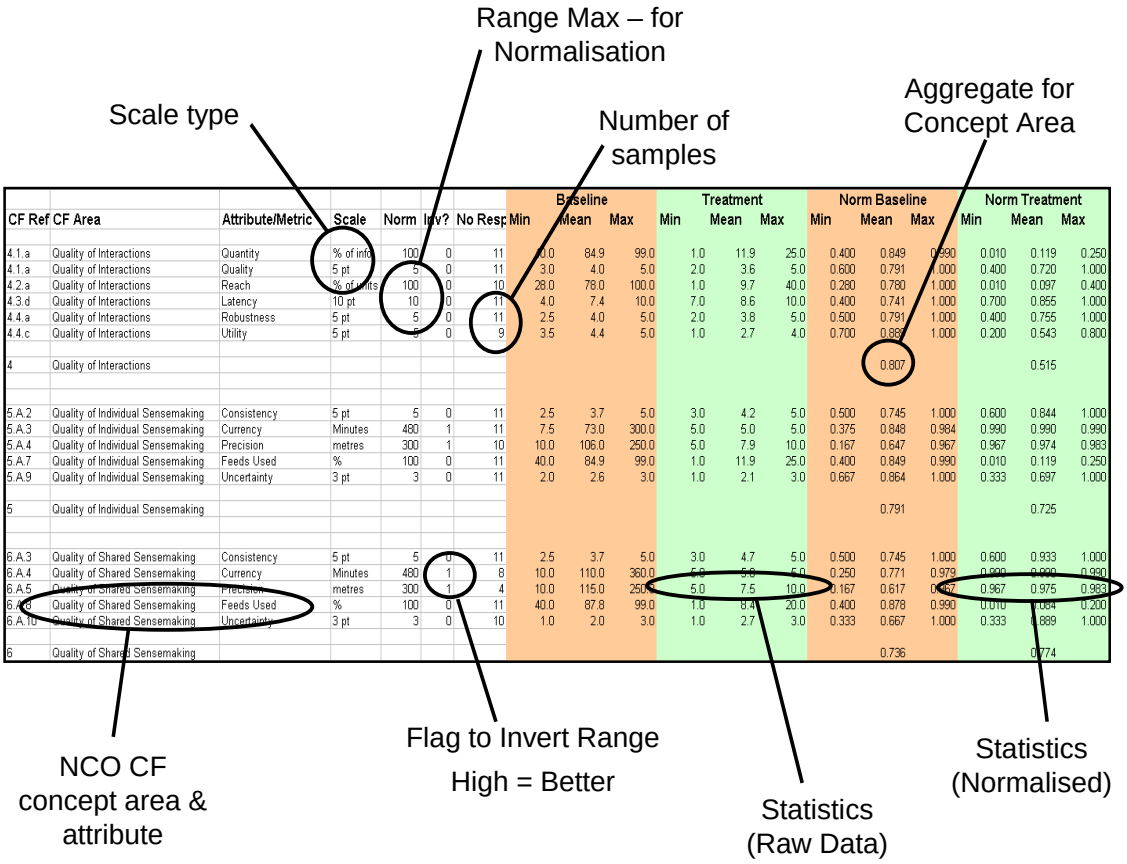
- Number of samples
- Mean value
- Range (minimum, maximum)

The second stage of the data analysis process was to normalize the statistical data from each question so that it fitted within a zero to one scale, where higher scores always represented "better". For most scales this simply involved re-scaling from a N-point scale to the required zero to one scale by dividing the answer by the maximum range of the scale. In a few cases the scales had no implicit maximum range (e.g. accuracy in meters), in which case a maximum was derived by eye from the range of answers provided.

For some attributes the questions elicited an answer on an absolute scale in which low was better, e.g. time lag in minutes. In these cases the normalization contained the additional step of reversing the scale so that high represented better.

Third, an aggregate score for each whole NCO concept area was calculated by averaging the scores achieved for each attribute within that area.

A segment of the data analysis spreadsheet is shown below with the appropriate elements associated with these data analysis stages annotated.

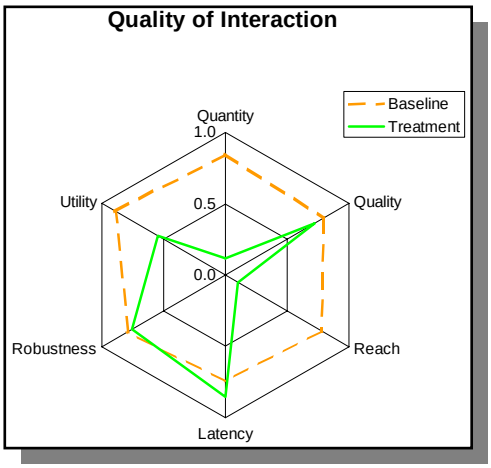


							Baseline			Treatment			Norm Baseline			Norm Treatment		
CF Ref	CF Area	Attribute/Metric	Scale	Norm	Inv?	No Resp	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max
4.1.a	Quality of Interactions	Quantity	% of info	100	0	11	70.0	84.9	99.0	1.0	11.9	25.0	0.400	0.849	0.990	0.010	0.119	0.250
4.1.a	Quality of Interactions	Quality	5 pt	5	0	11	3.0	4.0	5.0	2.0	3.6	5.0	0.600	0.791	1.000	0.400	0.720	1.000
4.2.a	Quality of Interactions	Reach	% of units	100	0	10	28.0	78.0	100.0	1.0	9.7	40.0	0.280	0.780	1.000	0.010	0.097	0.400
4.3.d	Quality of Interactions	Latency	10 pt	10	0	11	4.0	7.4	10.0	7.0	8.6	10.0	0.400	0.741	1.000	0.700	0.855	1.000
4.4.a	Quality of Interactions	Robustness	5 pt	5	0	11	2.5	4.0	5.0	2.0	3.8	5.0	0.500	0.791	1.000	0.400	0.755	1.000
4.4.c	Quality of Interactions	Utility	5 pt	5	0	9	3.5	4.4	5.0	1.0	2.7	4.0	0.700	0.883	1.000	0.200	0.543	0.800
4	Quality of Interactions													0.807			0.515	
5.A.2	Quality of Individual Sensemaking	Consistency	5 pt	5	0	11	2.5	3.7	5.0	3.0	4.2	5.0	0.500	0.745	1.000	0.600	0.844	1.000
5.A.3	Quality of Individual Sensemaking	Currency	Minutes	480	1	11	7.5	73.0	300.0	5.0	5.0	5.0	0.375	0.848	0.984	0.990	0.990	0.990
5.A.4	Quality of Individual Sensemaking	Precision	metres	300	1	10	10.0	106.0	250.0	5.0	7.9	10.0	0.167	0.647	0.967	0.967	0.974	0.983
5.A.7	Quality of Individual Sensemaking	Feeds Used	%	100	0	11	40.0	84.9	99.0	1.0	11.9	25.0	0.400	0.849	0.990	0.010	0.119	0.250
5.A.9	Quality of Individual Sensemaking	Uncertainty	3 pt	3	0	11	2.0	2.6	3.0	1.0	2.1	3.0	0.667	0.864	1.000	0.333	0.697	1.000
5	Quality of Individual Sensemaking													0.791			0.725	
6.A.3	Quality of Shared Sensemaking	Consistency	5 pt	5	0	11	2.5	3.7	5.0	3.0	4.7	5.0	0.500	0.745	1.000	0.600	0.933	1.000
6.A.4	Quality of Shared Sensemaking	Currency	Minutes	480	1	8	10.0	110.0	360.0	5.0	5.0	5.0	0.250	0.771	0.979	0.990	0.990	0.990
6.A.5	Quality of Shared Sensemaking	Precision	metres	300	1	4	10.0	115.0	250.0	5.0	7.5	10.0	0.167	0.617	0.967	0.967	0.975	0.983
6.A.8	Quality of Shared Sensemaking	Feeds Used	%	100	0	11	40.0	87.8	99.0	1.0	8.4	20.0	0.400	0.878	0.990	0.010	0.084	0.200
6.A.10	Quality of Shared Sensemaking	Uncertainty	3 pt	3	0	10	1.0	2.0	3.0	1.0	2.7	3.0	0.333	0.667	1.000	0.333	0.889	1.000
6	Quality of Shared Sensemaking													0.736			0.774	

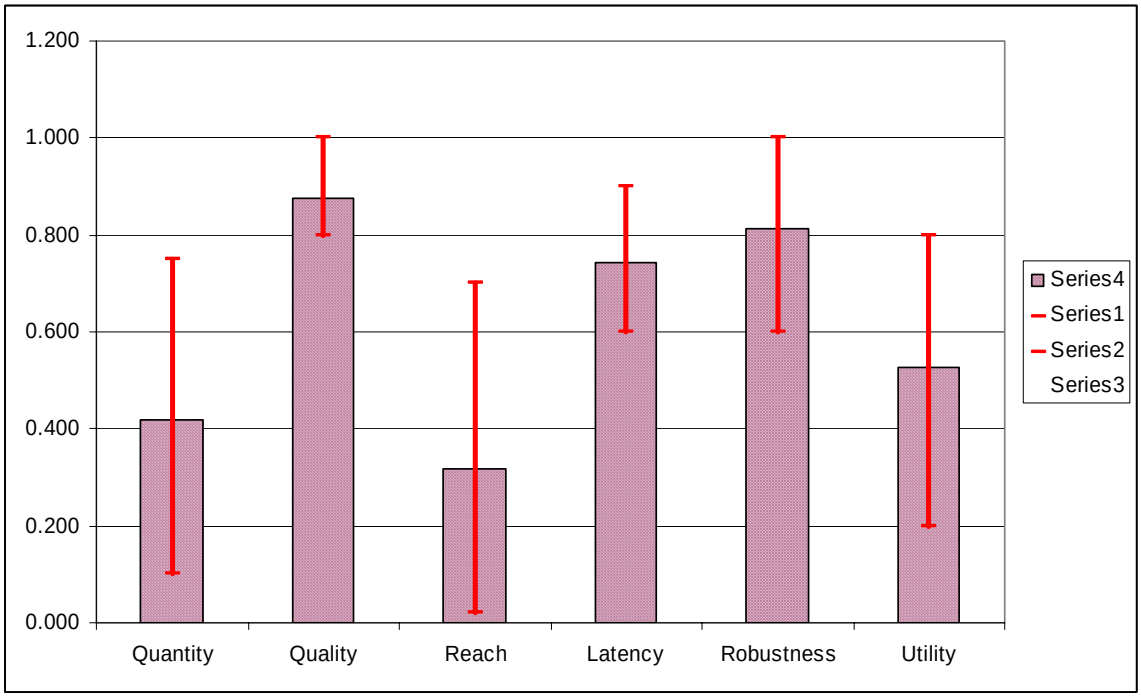
E.5 DATA PRESENTATION

The normalized statistical data can be presented in a number of ways to emphasize different aspects or provide information to different types of user.

The data presentation used in previous NCO CF case studies included Kiveat diagrams that compared the baseline and treatment for all of the attributes within a particular NCO concept area simultaneously, as shown below. Although this diagram can present a lot of data in a compact form, these diagrams are readily assimilated by all users and it is not practical to present the data range for each attribute on the same diagram.



An alternative presentation of the same data is the bar chart representation shown below. This format is readily assimilated by most users and it is possible to present the data range for each attribute without making the diagram too busy.



F.6 OBJECTIVES

F.6.1 The objective is more narrowly focused on FBCB2/BFT. Study did not look at AFATDS, other digital systems, networks.

While the study looks specifically at the impact of FBCB2/BFT within the overall context of the NCO CF as requested by DoD, in the course of our interviews, we did ask questions about other systems/technologies that were available pre-LD and post-LD and cover the general quality of networking in our Final Report.

It is true that there are other technologies, digital and otherwise, that ultimately contributed to force effectiveness. These technologies may complicate or confound the "treatment". We highly recommend that in future studies a more comprehensive analysis be done on the overall quality of networking and information sharing and its impact on MoMs.

F.6.2 What was FBCB2/BFT's impact on warfighting (along dimensions of DOTMLPF)? Study suggests there was an impact, but extent is not apparent from results presentation.

This is addressed in the Final Report. In our discussion of "variables", FBCB2/BFT (and its accompanying L-Band satellite communications capability) is evaluated as the independent variable that ultimately impacts force effectiveness. DOTMLPF is treated as an exogenous variable and we spend considerable time assessing this within the context of our Final Report.

F.6.3 Articulate scope constraints due to project timeframe and resources.

This has been addressed in both scope and constraints.

F.6.4 Hypothesis statement format. Make explicit assumptions embedded in hypothesis and subsequent test. Is the hypothesis a prove-able/disprove-able statement?

This has been addressed in the Final Report.

F.6.5 Comparison in the study seemed to be between what benefit was gained from FBCB2/BFT vs. what was gained from CNR.

In some cases, the questions we developed actually asked for a comparison of the two. In general, however, the forces were LOS radio equipped prior to OIF. This capability was enhanced post-LOD with FBCB2/BFT which was L-Band satellite enabled. Our intent was to compare capabilities pre-LOD (baseline) and capabilities post-LOD with FBCB2/BFT (treatment). As discussed elsewhere in this document, based on our experience during the interview process, we would now change some of the wording of our questions in the questionnaire to make sure that they addressed the benefits post-LOD of CNR plus FBCB2/BFT which would eliminate comparison of CNR against FBCB2/BFT.

F.7 OPERATIONAL CONTEXT

F.7.1 Implied comparison between UK and US forces. UK with FBCB2/BFT vs. US with FBCB2/BFT (but more densely and more fully trained)

This is generally true. Given the results of research within UK combat units, there was a general feeling amongst the case study team and EBR/DoD stakeholders that we needed to evaluate other combat units to see if similarities or differences existed. In fact, had there been enough resources and time, we would have done more interviews within the 1 MEF, including 15 MEU, as well which would have resulted in a similar "implied comparison". We do not consider this a problem or issue as long as the reader understands that we are trying to ask identical questions within the context of the NCO CF to determine why certain differences or similarities existed. This adds additional richness and dimension to our study.

F.7.2 Result reinforced fielding/training issues. Argument for including that comparison in hypothesis. Though arrived at via discovery learning, not a pre-defined test

We have addressed this in the Final Report. We have not changed our hypothesis, although the observation regarding arriving at the impact of training or lack thereof and its impact on ability to use the technology effectively and ultimately transform mission effectiveness is valid.

F.7.3 Roles and missions well-stated, as were deployments of FBCB2/BFT in UK force

No response required.

F.7.4 Describe better how FBCB2/BFT was deployed in US forces

We have addressed this in the Final Report.

F.7.5 Motivation for deployment of FBCB2/BFT in UK force - Combat ID

Our findings were that the issues of combat identification and fratricide prevention were discussed in relation to deployment of FBCB2/BFT within UK combat units.

F.8 SCOPE AND ASSUMPTIONS

F.8.1 Study's focus is more tactical than operational. Though anecdotal evidence suggests that its operationally useful. Focus also on units that had FBCB2/BFT.

This is true. As noted in this Final Report, and as was decided early on in the study, due to issues relating to scope and numbers of interviews we could realistically conduct within budget, we would focus on individual combat units and face-to-face interviews with decision makers involved in actual combat operations who used FBCB2/BFT.

F.8.2 Units that didn't have FBCB2/BFT also benefited from the presence of FBCB2/BFT in other units (SA passed via C2PC, ABCS. Significance of

second-order benefits of FBCB2/BFT when networked. Extended SA - and what the consequences are – so what if you have extended SA? We understand that there are benefits of FBCB2/BFT that provided extended SA.

This is correct and became very apparent through our initial research and the interview process. There were instances of individuals from non-FBCB2/BFT equipped units going to the TOC or CP to view developments on FBCB2/BFT during pauses. Additionally, since FBCB2/BFT provided feeds into the COP, there were those who benefited from BFT feeds who did not have direct access to the FBCB2/BFT itself. This, again, is an area worthy of further analysis, although we do not specifically address this "second-order" benefit in our case study.

F.8.3 Another approach: Hypothesis as assumptions. Assume FBCB2/BFT gives you better SA, better interactions, better shared sensemaking – if true, this will get you: Less fratricide, better decisionmaking, better time management; and, better flexibility in maneuver options.

This is actually addressed to a degree. Of course, by definition, our study did not and could not "assume" what is suggested above. That being said, our study does go on to look at force effectiveness and some elements of what is suggested. Fratricide is specifically excluded from the scope of our study, although we recommend that it be part of some future study.

F.9 APPROACH

Interviews

F.9.1 Articulate the difference between "informing" interviews and "instrumental" interviews?

We have incorporated this recommendation into our Final Report.

F.9.2 1 Black Watch involved in significant combat in Basra – are there opportunities to interview? Are there opportunities to interview UK units that did not have FBCB2/BFT (Formation Recce)?

As discussed in the Scope section, we were limited in the number of interviews we could physically conduct. As mentioned earlier in this report, we did attempt to schedule additional interviews with some units but, due to the availability of the units, we were unable to meet with them.

F.9.3 Articulate how and why the units were chosen for interview.

We have incorporated this into our Final Report. It was actually explicitly covered in all of the previous workshops and deliverables but we have addressed it again in our Final Report.

F.9.4 Ensure appendices include details about development and content of interview questionnaires.

We have done this in our Final Report.

F.9.5 State the degree to which interviews in alternative units are not good points of comparison.

This comment refers to the fact that we have conducted interviews with 3ID combat units (specifically the 1 BCT) using the same hypothesis and questionnaires that we used for 1UK Armored Division and its subordinate units. While we still use the findings from our 3ID interviews to serve as a basis for comparison against our findings from 1 UK Armored Division, we recognize that you cannot make a direct comparison between these units and their respective missions.

F.10 FINDINGS AND INSIGHTS

F.10.1 Ensure results comparisons are consistent with the comparisons aimed for in the hypothesis. Clarify or resolve treatment vs. control in hypothesis and results.

We have attempted to address this in the Final Report.

F.10.2 Small number of interviews raises questions about statistical validity of quantitative conclusions. Make explicit that interviews are not random sample, but rather were selected for subject matter expertise.

We have addressed this in the Final Report.

F.10.3 Study does a good job of correlating results to the top-level and attributes of NCO conceptual framework. Can cross-walk study with framework. Can clearly see the conclusions and how they tie to the story line.

Agree.

F.10.4 SA is not only FBCB2/BFT.

We agree that FBCB2/BFT was not the only source of SA. It was and is not our intent to imply this.

F.11 INTERPRETATION/ANALYSIS

F.11.1 More discussion needed about the conditions of FBCB2/BFT deployment and the consequences of those conditions. More description of BFT deployment in US forces needed. Data gleaned from interviews to explain why U.S. results differ from U.K. results.

We have attempted to address this in the Final Report.

F.11.2 Key emerging issue in study.

This refers to the issue that we have begun seeing several factors that contributed to the propensity to use, and the benefits derived from the deployment of, FBCB2/BFT. We have addressed this in our Final Report. Some of these included culture, training, distances maneuvered, quality of existing voice communications, familiarity with technology prior to LOD, etc.

F.11.3 Possibly discuss in context of risk calculation done by potential UK users.

To be addressed.

F.11.4 Assumptions about definition of control/treatment groups led to confusion over kiveat charts.

We believe that this has been addressed and clarified in the Final Report.

F.11.5 Define feeds used.

We are considering changing the term "feeds used" – to be determined.

F.11.6 What is baseline? What's added by FBCB2/BFT? What the level of SA, etc. is for units with FBCB2/BFT and CNR?

Addressed in Final Report.

F.11.7 May not be possible to show cumulative FBCB2/BFT+CNR results given current methodology.

This is a correct observation. Given the way that certain questions were posed, we were not able to say that "this is the cumulative impact of FBCB2/BFT+CNR" although one could infer this from the findings.

F.12 VIGNETTES/STORIES

F.12.1 Vignettes important illustrations – aren't apparent from spiderweb diagrams.

This is addressed in the Final Report and Final Brief

F.12.2 Videotapes of interviews exist – try to integrate video stories into presentations/multimedia reports. Meaningful to Service/Allied consumers. Adds credibility/depth.

Agree. Assuming we obtain the appropriate permissions from interviewees, we will integrate video-taped relevant vignettes/stories from interviews into our Final Brief for the CCRT Symposium.

F.12.3 Innovators/early adopters chart illustrating cultural differences needs to be well-explained and referenced.

This is addressed in the Final Report.

F.13 PEER REVIEWERS

No comments received for this requirement.

F.14 RECOMMENDATIONS FOR OPERATIONAL AREA OF STUDY AND NCO CF

Operational Area of Study

F.14.1 Utility of separating SA into Blue, Red, Environment components:

This is addressed in the Final Report.

F.14.2 What portions of pictures were used and not used, and why?

The interviews capture this kind of information and the answers are documented in the questionnaires. We will address a certain amount of this in the Final Report.

F.14.3 While separating SA useful, also need to represent/ measure integrated understanding of holistic picture (cognitive)

No action at this time.

F.14.4 What does exogenous mean (a "consultant's term")?

We could, in fact, say "other factors" although the term exogenous is common in research terminology. Exogenous in the context of its usage here, and in line with Webster's definition means "produced from without: originating from or due to external causes" or "caused by a factor (as food) or an agent from outside the organism and not due primarily to structural or functional failure *exogenous obesity* or "originating from outside the organism". In the context of the NCO CF, DOTMLPF become exogenous variables. We are open for suggestions here.

F.14.5 Place more emphasis on how doctrine, training, etc. impact network-centricity

This is addressed to some degree in the Final Report.

NCO Conceptual Framework

F.14.6 WG Observation: NCO CF does not seem to provide a mechanism to easily examine full range of DOTMLPF aspects of MCP. Already complex – how to add this capability without increasing complexity

This needs to be further explored.

F.15 LESSONS LEARNED FOR FUTURE CASE STUDIES

F.15.1 FBCB2/BFT study is a critical network-centric issue: going from voice comms to a digital, networked capability.

Agree.

F.15.2 If future studies are done, it may be worth going back and capture what this study was not able to capture due to resource/time constraints.

Agree.

F.15.3 Suggest that a follow-on study of this issue would have high payoff.

Agree.

F.15.4 Resource constraints have proven to constrain research designs, scope, and analysis.

Agree.

F.15.5 Good, fast, cheap: Pick any two.

No comment.

F.15.6 Storytelling/presentation is important: needs resources.

Agree. Capturing the stories via face to face interview requires time and resources.

F.15.7 Translate the key concepts of the NCO framework treated in the case study into Joint/Coalition terms used by the warfighters.

Agree.

F.15.8 Use existing terms as much as possible.

Agree.

F.15.9 If not possible, submit for inclusion in JP 1-02.

No comment.

F.15.10 Collecting cognitive data is hard – study teams need support and resources to figure this out. E.g., Interview formulation: provide types of questions used before to get at particular issues.

Agree.

F.15.11 General: Collect lessons learned on "how to do case studies on NCO" to provide to future research teams.

Agree.

APPENDIX G:DETAILED NCO CF RECOMMENDATIONS

NCO CF Area for Consideration	Issue/Perceived Weakness	Proposed Action
General – All areas	Certain definitions and corresponding metrics difficult to translate into meaningful interview questions	Expand on list of possible questions depending on the source of information; begin compiling examples of questions from various case study questionnaires
General – All areas	Many attribute definitions and metrics are liable to variations in interpretation	Further refine and clarify the attributes and metrics; document multiple examples of potential measuring tools/approaches; compile examples of possible measures used in case studies
General – All areas	Sources of data for certain metrics difficult to identify	Document possible sources of data and information related to metrics being gathered: e.g. Studies and Analysis, G3, Information Officer, AARs
General – All areas	Multi-disciplinary review of NCO CF	Have various research disciplines (psychology, sociology, operations research) review, evaluate and improve upon framework
NCO Conceptual Framework	Weakness in consistency and completeness in descriptions, explanations, measures and metrics for each of the attributes	Update document per results from NCO Workshops and case studies. Include examples from case studies

NCO CF Area for Consideration	Issue/Perceived Weakness	Proposed Action
Application of NCO to combat operations	Lack of "User friendliness" of NCO CF to operators/warfighters	Create a field guide that helps adapt the NCO CF to real world combat scenarios that facilitate the collection of information and data
NCO CF Data Collection Tools	Non-existence of automated tools to collect information/data	Evaluate development of online standardized NCO CF questionnaires that facilitate data- to augment data collection/analysis (may depend on case study)
General – All areas	Limited coalition operations studied	Evaluate additional dimensions to model that address issues related to the application of the model to coalition network centric operations based on experience in case studies. Examine questions that may relate to DOTMLP
General – All areas	Impact of doctrine and effective training not fully addressed as relates to impact on NCO CF concepts, domains, and attributes	Review how well issue of training related to use of technologies is addressed in NCO CF and its implication to Degree of Networking, Quality of Information Sharing, Individual Awareness, Quality of Interactions, etc.
General – All areas	Relevance of liaison personnel (LNOs, ANGLICOS) to NCO CF unclear	Review where and how liaison element feeds into NCO CF

NCO CF Area for Consideration	**Issue/Perceived Weakness**	**Proposed Action**
General – All areas	Cultural aspects not taken into account	Evaluate in depth the impact of culture as relates to application of NCO CF)e.g. differences between services and coalition forces and impact on leveraging NCO capabilities)
General – All areas	"Stages" of transformation to NCO not addressed	Explore implications of and compare various "stages" of transformation to NCO that may be taking place – for example, stage of transformation of 4ID versus 3ID, versus 1MEF, versus 1U Armored Division, versus…
Quality of Networking	Pre-definition, ranking of networks supporting operations	Use previous studies that evaluate, standardize quality of information networks in place for various combat operations that are reusable or can be shared among case study team members. For example, a study on comprehensive definition, "ranking/rating" using NCO CF, of the network/C2 systems in place to support OIF that could be used by anyone exploring specific case studies related to combat operations and units (1MEF, 3ID, 4ID, 1 UK Arm Div, etc.) leveraging the network. When evaluating concepts/attributes that depend on networking, prior studies could be used as a reference.

NCO CF Area for Consideration	Issue/Perceived Weakness	Proposed Action
General – All areas	Human factors	Involve Human Factors organizations in NCO CF review and analysis
General – All areas	Perceived lack of involvement/understanding of OA/Studies and Analysis	Involve more OA/Studies and Analysis personnel with teams involved in development and application of NCO CF. Explore OA tools and models to enhance data collection and analysis
Quality of Interactions	Lack of measures/metrics	Develop measures/metrics
Individual and Shared Awareness	Vagueness of some measures/metrics	Refine and explain in further detail the measures/metrics along with examples, sample questions, potential sources of data
Degree of Information Share-ability	The model implies one model for share-ability. Consideration is given to the quantity of information, the ability to retrieve and exploit it. However, within a system there will be many types of information, some more important than others, that impact upon the effectiveness of the network. Consequently, the types of information and the ability to exploit it within the system must be articulated.	Incorporate information needs, availability and ability to exploit information into the model. The main information needs, the volume of information and, most importantly, the quality of information needs to be articulated.
Degree of Shared Sense-making	Commanders make decisions. These decisions are not made by consensus or majority rule. Consequently, the term "collaborative decisions" is misleading and inaccurate.	In order to reliably reflect shared sense-making, consider using the term: "Contribution to Decision-making". This accounts for the system (people and technology) that contribute to the commander's decision-making process

APPENDIX H: COPIES OF INTERVIEWS CONDUCTED

Copies of interview files are available electronically.

Please see the NCO CF CD included with this document: Appendix H - Interviews

Office of Force Transformation, Office of the Secretary of Defense
1000 Defense Pentagon, Washington, DC 20301-1000
www.oft.osd.mil

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